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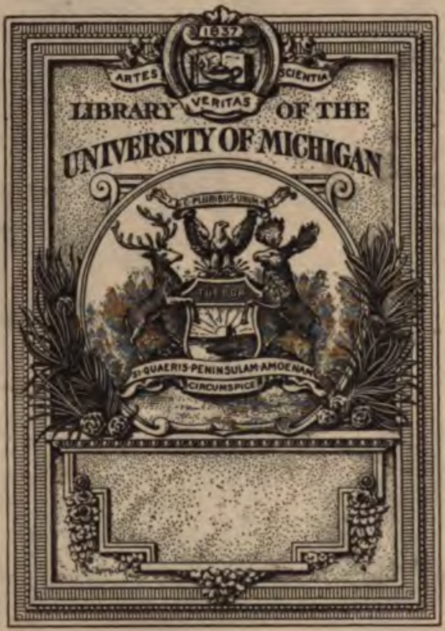

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A MANUAL

OF

PERSONAL HYGIENE

Proper Living upon a Physiologic Basis

BY AMERICAN AUTHORS

EDITED BY

WALTER L. PYLE, A.M., M.D.

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THIRD EDITION, REVISED AND ENLARGED

PHILADELPHIA AND LONDON
W. B. SAUNDERS COMPANY
1907

Set up, electrotyped, printed, and copyrighted May, 1900. Reprinted and recopyrighted April, 1901. Revised, reprinted, and recopyrighted August, 1904. Reprinted August, 1905. Revised, reprinted, and recopyrighted January, 1907

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PREFACE.

The object of this manual is to set forth plainly the best means of developing and maintaining physical and mental vigor. Throughout the book there is concise but adequate discussion of the anatomy and physiology of the parts under consideration, upon which is based the subjoined advice. In other words, there is an exposition of proper living upon a physiologic basis. Purely technical phraseology has been avoided, as far as compatible with the scientific value of the text, and numerous explanatory diagrams and illustrations have been introduced. Although each special chapter is complete in itself, there has been purposive repetition of remarks upon subjects of such general interest as eating, drinking, breathing, bathing, sleep, exercise, etc., in order that they may be discussed more thoroughly from several standpoints.

WALTER L. PYLE.

PREFACE TO THE THIRD EDITION.

In response to a growing demand, the work has been thoroughly revised and numerous additions have been made, including an illustrated System of Home-Gymnastics, a chapter on Domestic Hygiene, and an Appendix, containing the simpler methods of Hydrotherapy, Thermotherapy, and Mechanotherapy, and a section on First Aid in Medical and Surgical Accidents and Emergencies. A concise Glossary of the purely medical words unavoidably used in the text has been especially prepared for the convenience of non-medical readers.

WALTER L. PYLE.

1806 Chestnut St., Philadelphia.

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INTRODUCTION.[1]

STRANGE as it may seem, the one subject which every fair-minded person admits should be taught thoroughly—namely, how to keep healthy—has been largely neglected. With all the recent agitation for educational reform, there remains, in a measure, the same indifference to the proper teaching of the care of the body, regarding which Herbert Spencer lectured the pedagogic world over forty years ago.

Mr. Spencer proved that knowledge may have intrinsic value, and that the value of some knowledge must be greater than that of others. In our brief lives it is most necessary to distinguish and give precedence to the useful, real, and effective over the non-useful, conventional, and ornamental ; or, to use a Baconian phrase, "we must determine the relative value of knowledges." All knowledge passes into action, and that knowledge that leads men to better physical lives is a communal as well as an individual gain. Mr. Spencer says that, in the order of their importance, the leading kinds of activity which constitute human life are :

1. Those activities which directly minister to self-preservation.

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[1] A considerable portion of this introductory chapter is from an address by the editor in opening the Symposium of the American Academy of Medicine, on the "Teaching of Hygiene in the Public Schools," in Washington, D. C., May 11, 1903.

2. Those activities which, by securing the necessaries of life, indirectly minister to self-preservation.

3. Those activities which have for their end the rearing and disciplining of offspring.

4. Those activities which are involved in the maintenance of proper social and political relations.

5. Those miscellaneous activities which make up the leisure part of life, devoted to the gratification of the taste and feelings.

In other words, a rational order of subordination is : Education which prepares for a direct self-preservation ; that which prepares for an indirect self-preservation ; that which prepares for parenthood ; that which prepares for citizenship ; and that which prepares for miscellaneous refinements.

It is stated with great emphasis that without doubt the actions and precautions which from moment to moment secure self-preservation are of primary importance ; and that, "as vigorous health and its accompanying high spirits are larger elements of happiness than any other things whatsoever, the teaching how to maintain them is a teaching that should yield in moment to no other whatever."

Fortunately, knowledge subserving direct self-preservation is largely provided for by nature. The common animal instincts give warning against gross dangers. The inquisitive, timid, restless infant is chiefly concerned in hourly acquisition of the primitive faculties of coördination, estimation of distance, size, consistence, and weight, the avoidance of things likely to cause pain, the assimilation of food, etc. Throughout childhood and youth there is a further elaboration of these primal requisites. But more than this is necessary, for besides the mechanical dangers, there are the evils following breaches of physiologic laws. Unfortunately, so profound is the innate ignorance of these laws of life that it is often not even known that our sensations are our natural and most trustworthy guides. The less evident but no less real dangers arising from the complexities of modern social life and the attendant evil habits are continually present, despite all innate instincts of warning. The pernicious influence of improper food and bad air, the abuse of stimulants and narcotics, the modern dissipations and vices, etc., can be modified only by proper and timely education.

It has been said that "health is man's birthright; that it is as natural to be well as to be born," and that from ignorance and transgressions of physiologic and hygienic laws arise most disease and tendency to disease. Yet to-day, so tardy has been the recognition of the importance of instruction in the fundamental principles of applied physiology as a means to complete living, that a thoroughly well person after middle life is the exception in every community. On every side we find chronic complaint, physical weakness, weariness, and overwhelming gloom, which might have been prevented by proper timely instruction.

A striking example of the sacrifice of health from avoidable and preventable suffering is the great number of physical and moral wrecks, the victims of the very prevalent habit of worry. So close are the relations of the mind and the body that one of the most prolific sources of suffering is continuous worry, and one of the surest ways to restore health that is threatened is to keep the mind cheerful and hopeful. Excessive ambition, misdirected energy, longing for the unattainable, regret for the unalterable, anticipation of future happenings, lack of a sense of perspective, fretting over non-essentials, indecision, reopening of troublesome questions already settled, avarice, selfishness, excessive emotions, uncontrolled passions, and the actual cultivation of the melancholic state, are some of the important causes of mental anguish and subsequent physical suffering that are not commonly associated with the baneful breaches of hygienic laws to be demonstrated by teachers of practical physiology. With those who are physically or mentally defective we have the patience to reason and to make allowance for, but little sympathy or guidance is offered to the practically normal person who is gradually becoming the slave of a cultivated habit of worry, letting the minor trials and troubles of a day shut out much of the sunshine and happiness of life. The spiritual sin of worry and its utter futility should be made plain, but its association with chronic ill-health needs more discussion in both schools and churches. Observance of such teaching would do much to lessen the great American army of neurasthenics.

Besides the individual suffering from preventable illness, time and money are ruthlessly wasted, commercial and artistic instincts are curtailed, good parenthood and citizenship are rendered impossible, appreciation of amusement is dulled, and, besides being immensely deteriorated, life is markedly shortened. "Is it not clear," asks Mr. Spencer, "that the physical sins—partly our forefathers' and partly our own—which produce this ill-health deduct more from complete living than anything else, and to a greater extent make life a failure and a burden instead of a benefaction and a pleasure?''

Most cases of illness are preventable, and Mr. Huxley says we should look upon them as criminal. Illness following disobedience of physiologic laws should be regarded as the punitive result of reprehensible conduct and not as a simple grievance. There is such a thing as physical morality and the preservation of health should be considered a sacred duty. Persons who treat their bodies as they please and transgress rules of personal hygiene of which they should have a definite understanding are physical sinners, and they are not only committing a crime against themselves, but often against their dependents and future generations.

Public hygiene may be enforced, but personal and domestic hygiene must be taught. No law can compel citizens in times of epidemics of typhoid fever or cholera to boil their drinking-water and cleanse food that is to be eaten without cooking, but persistent warnings from the health-authorities, public lectures, and literature from physicians, and newspaper and periodical discussion will be of the greatest service in combating the spread of disease. General sanitary improvement is dependent upon the intelligence of the community, as well as upon efficient health-officials, and one of the important duties of the latter should be to strengthen public confidence and disseminate more widely knowledge concerning public, domestic, and personal hygiene.

It is not merely the teaching of the rules of hygiene that is needed, nor the ordinary course in school-physiology. Personal hygiene is applied physiology, and a proper understanding of certain elemental truths must be acquired before they can be applied. Knowledge of the normal functions of the body and the simple methods of keeping them in healthy action is the one thing that no educated person should be excused from possessing; yet most of our children reach maturity without sufficient parental or scholastic instruction in many essential matters of health. Men and women who would be greatly chagrined to be corrected in the pronunciation of a popular foreign proper name, or who would resent as an insult any imputation as to their lack of general culture or learning, show not the slightest embarrassment at their ignorance of the common physiologic functions of digestion, circulation, respiration, etc. Persons of intelligence continually furnish thoughtless recommendations of purely "quack" remedies and unscientific instruments and apparatus; and advertisements of these articles may be seen in the best general and religious periodicals.

Concerning the popular desire of the British University patrons for the classic instruction, Mr. Spencer says: "While anxious that their sons should be well up in the superstitions of two thousand years ago, they care not that they should be taught anything about the structures and functions of their own bodies—nay, would even disapprove such instruction. So overwhelming is the influence of established routine! So terribly in our education does the ornamental override the useful!" Is this not a fairly applicable arraignment of not a few American parents—especially as to the daughter's education? yet it is to the mothers of to-day that the regimen of the nursery, the rearing of children, the preparation of food, and the problems of domestic hygiene are largely left.

The literature for the layman pertaining to personal hygiene is in great measure unsatisfactory and irresponsible. Many of the so-called "health books" are of very questionable authorship, often the compilation of a layman, perhaps an amateur pathologist, an inaccurate physiologist, a moralist of vague opinions, with, unfortunately, a tendency to cater to the prurient. Such books make hypochondriacs of their readers, and if they include advice as to self-treatment, they may do great harm. It is the duty of the professional author to stem and correct any morbid attitude of his readers, and not to add to it under the pretext of necessary explanation. In this connection may be aptly quoted the following abstract from a recent editorial in the *British Medical Journal:* "If we may speak for parents in the medical profession, it is impossible to suppose that wise fathers and mothers could desire to suggest to their sons or daughters either certain problems raised or in many cases the explanations proffered. There is a multitude of the best parents who think that their way is not made easier by the so-called moral reformer, but rather the reverse. And there are many of the most wholesome-minded boys and sweetest girls who hate him with a perfect hatred. The rest would probably do very well without him."

Many of the so-called "school-physiologies" fall short of their purpose by an inadequate conception of the proper methods of teaching hygiene. Not uncommonly they are filled with a mass of intricate and useless anatomic data, and abstruse and unsettled questions in physiology that can be of no possible aid to either teacher or pupil in the practical application of the principles of personal hygiene. It is of great importance to begin this teaching early, before habits of carelessness and indifference to things hygienic are formed. For this reason the home and the primary schools are by all means the places where the "gospel of health" should first be promulgated. If parents and teachers are given the proper literature from which to prepare their instruction, they can readily impart to very young children many of the most important lessons in practical hygiene—as, for instance, the principles of contagion and the advantages of cleanliness. Children more advanced may be taught by illustrated talks, without the necessity of text-book study, the salient principles of hygiene of digestion, proper breathing, the care of the eyes, ears, skin, etc., and these lessons may be so firmly impressed while the mind and character are in the developmental stage that they are never forgotten.

Some idea of the far-reaching effects of a general adoption of these simple methods of instruction in the proper care of the body may be formed from the following editorial comment of a prominent magazine[1] on the praiseworthy effort of the Teacher's College of the Columbia University in New York city to train teachers "to teach health":

"It may not be extravagant to say that this same movement is of larger possible benefit than anything which has hitherto been done in the name of education, for if it should ever come to pass that every pupil in the public schools should be brought naturally to a proper understanding of health and its relations to every other part of life and conduct, such a chance for the advancement of the human race would be given as no considerable section of society has yet ever had. If all easily preventable physical troubles were prevented, such an addition would be made to the energy and the good sense of the people as defies description. A merely incidental item of such social progress would be the incalculable saving of the money spent on quackery, and of the waste of energy that quackery causes."

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[1] *World's Work*, February, 1903.

In view of the great importance of personal and domestic hygiene and the deficient popular instruction in the prevention of disease, a glorious opportunity awaits the philanthropist who will devote his energy and fortune to this teaching by public lectures and the dissemination of authoritative literature through every State in the Union.

In literature and lectures on hygienic subjects too often the science is made too popular, or the popular exposition too scientific. There has also been too frequently a tendency to present as much of the "gospel of health" as may be put in popular form, or that, for ulterior motives, the layman may be induced to accept. Such attitude can only weaken the cause of preventive medicine among intelligent persons. It is not desirable to produce athletes, physical-culture fanatics, or practitioners of new-fangled and erratic "systems" and "pathies." What is needed is simple instruction by capable teachers in the proper care and use of the body, authoritatively based upon the best available modern anatomic, physiologic, and hygienic data. We should not have "every man his own physician," as seems often the object in lectures, periodicals, and books relating to health ; rather give every man fundamental knowledge that will enable him to understand, and, if necessary, formulate, the requisite rules of health, and to distinguish scientific medicine from quackery. Stripped of its superfluous technicalities, this knowledge may be imparted to any one of average intelligence and education, and it is desirable that more literature and personal explanation in this direction should come from the American medical profession. The subject is much too important to be left entirely in the hands of lay teachers and writers.

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A MANUAL OF PERSONAL HYGIENE.

HYGIENE OF THE DIGESTIVE APPARATUS.

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PHYSIOLOGY OF DIGESTION.

Mastication and Insalivation.—Digestion begins in the mouth with the mastication and insalivation of the food. Upon the thoroughness of the mastication, the disintegration of the larger and more resisting morsels and the thorough admixture of them with the saliva, depends in no small degree the comfort with which the gastric digestion is carried out. Starchy foods in particular require the effect of the **ptyalin**, a constituent of the saliva, by the action of which the starch, especially when thoroughly cooked, is converted into maltose. The saliva escapes into the mouth from three separate sets of **salivary glands**—the parotid at the angle of the jaw, the submaxillary along the side of the tongue, and the sublingual under the tongue. The mouth is further moistened by the secretion of the mucous membrane with which it is lined. The salivary secretion is excited by the presence of foreign bodies in the mouth, but especially by food. The action of the glands is controlled by the nervous system, and the effect of the higher nervous centers upon their activity may be instanced in the free flow of saliva that follows the odor of certain substances, and the sight, or even thought, of others. The saliva is slightly alkaline in reaction, and its activity differs in different individuals.

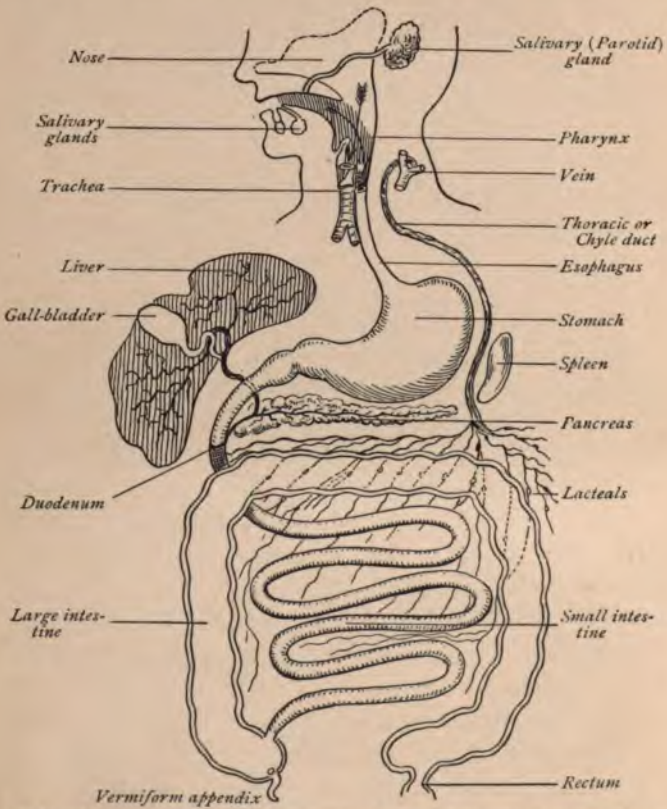

FIG. 1.—General scheme of the digestive tract, with the chief glands opening into it.

The conversion of starch into maltose by ptyalin is diminished in the presence of a slightly acid medium, and ceases in a free acid medium. If the saliva is diluted by water or other fluids, its activity is correspondingly diminished. Therefore foods should only be swallowed after they are thoroughly disintegrated by the teeth and sufficiently liquefied by the saliva to pass easily through the esophagus without the assistance of drink.

The stomach is a muscular sac, lying for the most part on the left side of the body and under the ribs. Its entrance, at the termination of the esophagus, is called the **cardia,** and is guarded by an increase in the circular muscle-fibers, by the contraction of which the opening is closed at the proper interval. Its outlet into the duodenum is called the **pylorus,** and this also is guarded by circular muscle-fibers, which close the opening so as to prevent the untimely escape of the gastric contents. The stomach is covered with a delicate serous coat, a part of the peritoneum, and is lined with a mucous membrane. In the adult the stomach, when filled, contains from two to three pints or more. It varies considerably in size and shape in healthy individuals. It is very richly supplied with blood-vessels and lymphatics; and the veins empty into the portal system going to the liver, not communicating directly with the general circulation. The mucous membrane secretes large quantities of fluid called **gastric juice,** which contains hydrochloric acid, and two ferments called, respectively, pepsin and rennet, or lab-ferment. The acid is mostly secreted toward the cardiac end of the stomach and the ferments near the pyloric end. During fasting the stomach is of a pale-pink color, and contains a small amount of fluid neutral in reaction. With the introduction of food the mucous membrane becomes of a deeper red color and the secretion becomes very abundant. As this secretion is acid in reaction, it might be supposed that the digestion of starch, begun in the mouth, would immediately cease in the stomach. Such, however, is not the case, owing to the fact that the earlier secretion of hydrochloric acid promptly combines with the albumin in the foods, so that free hydrochloric acid is for a time not present. A slight amount of lactic acid is found at this time; but it mostly comes preformed in the food, and is not the result of secretion, although to some extent it may come from fermentation even in the healthy stomach. After a certain period of time, varying in individuals from a few minutes to a few hours, the secretion of hydrochloric acid is in excess of that which may combine with the albumin; and it therefore appears as a free acid, at which time the trace of lactic acid disappears. As a result of the increased acidity, the digestion of starches, for the time being, comes to an end. On the other hand, the solution of the albumins, their conversion into peptones, and the breaking up of the covering of the fat-cells proceed rapidly. The cellulose of vegetables and fruits is broken up, and the absorption of certain constituents of the stomach-contents begins. All of these matters are greatly favored by the **muscular action of the stomach,** which by slow wave-like contractions (the cardia and the pylorus being closed) thoroughly mingle the gastric contents and assist in their solution and absorption. From time to time the better digested portions pass through the pylorus; but the solid particles stimulate pyloric contraction, and their escape into the intestine is therefore properly prevented. After the lapse of from four to seven hours the gastric digestion is practically completed, the organ having gradually emptied itself, and at length the pylorus relaxes sufficiently to allow the more insoluble remains to pass into the intestine.

Absorption from the stomach is of less importance than was formerly supposed. The alcohols, salts, certain extractive matters, and pure water may be, and to some extent usually are, absorbed directly from the stomach; but water in the presence of solid foods or blended with foods, as in soup, is apparently not so absorbed. A glassful of pure water is found to have left the stomach after a quarter or half of an hour, but when taken with food it escapes with the latter in the ordinary course of digestion. The office of the stomach, like that of the mouth, is to prepare the food for its final digestion in the intestine. The stomach has a very complex nerve-supply that governs its activity, and it is therefore subject to derangements that follow nervous excitation in various other parts of the organism.

The Small Intestine.—The intestine is described as consisting of two divisions, a small and a large intestine. The small intestine is about twenty feet long in the adult, and is subdivided into three portions: the **duodenum**, extending from eight to ten inches beyond the pylorus; the **jejunum**, which forms two-fifths; and the **ileum**, three-fifths of the remainder of the small intestine. Like the stomach, the intestine is lined by a mucous membrane, with columnar epithelium, and thickly set with secreting glands. It has a very vascular submucosa and is rich in lymphatics. A muscular coat arranged partly in circular and partly in longitudinal fibers lies outside of the submucosa. Finally, like the stomach, it is clothed with a serous membrane continuous with the lining of the peritoneal cavity. Between the muscular coats is arranged a system of fine nerves (**Auerbach's plexus**) which preside. over the movements of the intestine. In the submucous coats, extending from the stomach to the anus, are distributed the fibers of the nerves of secretion (**Meissner's plexus**). These nerves are provided with ganglion-cells, and it is probable that these are the centers that control the circulation, excretion, and secretion of the intestine. The surface of the mucous membrane of the stomach is enormously increased through the presence of the **valvulæ conniventes** and the **villi.** The former appear as numerous transverse folds projecting into the lumen of the intestine, and they interrupt and retard the current of the intestinal stream. Like other portions of the intestinal mucous membrane, they are covered with villi, one or two lines in length, so closely arranged that they project from the surface somewhat in the manner of fur. Between the villi are placed three kinds of glands differing somewhat in character and distribution. The tubular depressions of the mucous membrane, called the **glands of Lieberkühn,** extend throughout both the large and small intestines, increasing in size as they approach the anus. **Brunner's glands** are confined to the duodenum. They are placed in the submucosa and have excretory ducts; in structure and function they resemble the pyloric glands of the stomach. The **glands of Peyer** occur in the small intestine, but are most abundant in the lower portion of the ileum. Sometimes they are single, sometimes in clusters, when they are termed "agminate" glands, or Peyer's patches.

Accessory Digestive Organs.—The **liver** occupies a position on the right side of the body closely corresponding to that occupied by the stomach on the left. It moves with the diaphragm in respiration, and its secretion of bile passes in part temporarily into the **gall-bladder,** where it is stored until needed, but eventually is discharged through the common bile-duct into the duodenum, near the outlet of the excretory duct of the **pancreas.** The latter organ, lying transversely across the abdomen, below and behind the stomach, secretes a juice most important in the chemistry of digestion. In some respects it resembles the saliva in that it converts starch into maltose; but it is far more complex, and possesses a second ferment that digests albumin, and a third that emulsifies fats. The pancreatic juice, the bile, and the secretion of the glands of the intestine are alike alkaline in reaction. The **bile** may be regarded as an adjuvant in intestinal digestion, although it also contains waste matter cast off by the liver from the blood.

Digestion in the Intestine.—Of the secretions of the small intestine, that coming from the duodenum is the most important in its chemic action on food. The stomach-contents entering the intestine in the form of **chyme** are sharply acid in reaction, owing to free hydrochloric acid, and are semifluid or fluid in consistency. Chyme does not pass rapidly down the intestine, but its course is delayed through the intervention of the valvulæ conniventes and villi. It is soon rendered alkaline by the action of the intestinal secretion, the bile, and the pancreatic juice. These various secretions at once take up the role of digestion, the albumin being still further converted into peptone, and the starches into maltose, and cane-sugar into glucose, while the fats are emulsified. Absorption may begin through the activity of the veins and lacteals with which every villus, as well as other parts of the mucosa, is provided. When prepared, the available nutriments are absorbed from the intestinal contents through a process of selection, while certain harmful matters are discharged through the excretion of the glands. It is thus seen that there is a more or less continuous interchange of fluids between the intestine and the blood-vessels. The veins from the intestine discharge themselves through the branches of the portal veins into the liver ; the lymphatics, carrying much of the fat, empty themselves into the thoracic duct, and ultimately into the great central vein, or the vena cava. The blood from the stomach and intestines, freighted with aliment, passes to the liver, where the various substances are further modified and refined before their final reception into the systemic veins of the body.

The Large Intestine.—The small intestine is guarded by the ileocecal valve where it communicates with the large intestine. The latter is about four to six feet long in the adult, and is divided into three portions: the **cecum**, a short and relatively wide pouch, which has the **vermiform appendix** and communicates with the colon, the principal part of the large intestine. The **colon** has an ascending, a transverse, and a descending portion. The last-named, located on the left side of the abdomen, bends to form the **sigmoid flexure,** and finally reaches the **rectum,** which terminates in the **anus.** It is the office of the large intestine to retain the waste matter and overflow from the small intestine, and to hold the feces until its liquid portions are sufficiently absorbed. The sigmoid flexure acts as a valve and prevents the descent of the feces into the rectum until the act of defecation occurs. The feces should then be of proper consistency, and through contraction of the colon are discharged from the descending portion into the rectum, and with the assistance of the abdominal muscles and those of the rectum complete the process of evacuation.

HYGIENE OF THE TEETH.

Deformities.—As the result of inherited peculiarities the teeth are sometimes too large in proportion to the length of the jaws, and, as a result, they are forced out of line, and are crowded against each other, so that it is difficult to give them proper care. Such defects occasionally result from the too frequent habit of **mouth-breathing,** a practice that commonly follows obstruction to the nasal passages through hypertrophy of the adenoid tissue in the vault of the pharynx (see page 98.) The deformity referred to consists in narrowing of the hard palate and the maxillary

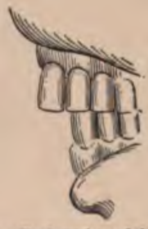

FIG. 2.—Deformity of the teeth caused by mouth-breathing.

arch, so that the line of the incisor teeth above project some distance beyond the line of the lower incisors, as illustrated in Fig. 2. The lower jaw is apt to recede, and the symmetry of the face is thereby disturbed as shown in Fig. 3. Fig. 4 shows the same face in which the lower jaw is brought forward in its proper position. A deformity somewhat resembling this results from the habit of "thumb-sucking." In this condition the upper in-

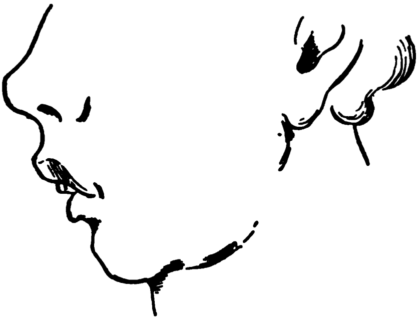

FIG. 3.—Asymmetry of the face due to a receding lower jaw, the result of mouth-breathing.

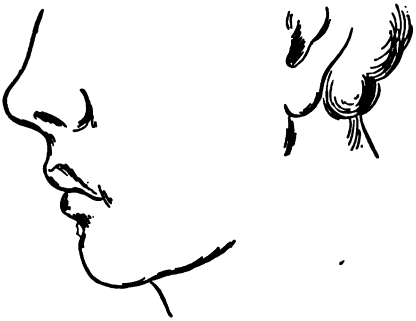

FIG. 4.—Lower jaw brought forward into its proper position.

cisors are directed outward and the lower incisors somewhat inward, as illustrated by Fig. 5. The habit of breathing through the mouth is commonly associated with that of "thumb-sucking." From whatever cause arising, habitual breathing through the mouth leads to the accumulation of organic matter about the teeth and thus favors the destruction of dentin. Certain families through several generations have soft or feeble teeth, apparently because of some congenital disturbance in the nutrition of the parts. It is commonly believed that in such individuals much more care is required to prevent the development of caries. These poorly developed teeth are sometimes seen in scorbutic or rachitic children, and in those suffering from congenital syphilis; but the condition is also present in those who in other respects appear to enjoy good health. In congenital syphilis the secondary teeth are affected in a characteristic way

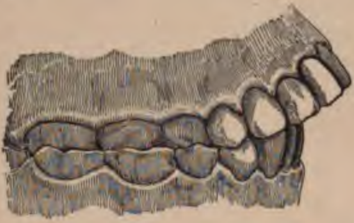

FIG. 5.—Deformity caused by thumb-sucking (Darby).

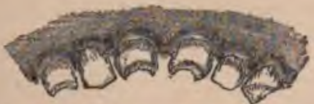

FIG. 6.—Teeth in congenital syphilis.

(Fig. 6). The incisors are peg-shaped, notched, and sometimes placed at such an angle that their cutting edges are found to meet. Many cases of irregular eruption of the teeth are improperly attributed to syphilis, and the same may be said of the notching that occurs along the teeth of many fairly healthy children—irregularities not identical with the peculiarities pointed out by Jonathan Hutchinson.

Causes of Decay.—It is commonly believed that in the matter of **resistance** and external irritation the teeth of certain individuals are naturally faulty. Even when the teeth receive reasonably intelligent care the development of caries is a constant source of anxiety; on the other hand, in certain families, and particularly in certain races, the teeth are naturally strong and are often retained until old age—even when they receive no further care than that which comes from vigorous use in the mastication of coarse and resisting foods. A like difference may be noted in the integument of people, and may be explained by assuming that this depends upon some peculiarity in nutrition. The **form of diet** has been thought by some to be a factor in caries of the teeth. It has been noticed that the teeth that are least called upon for mastication are often the most delicate. Strong and resisting teeth seem to come naturally to those who live upon coarse foods. Apparently the innervation and blood-supply is better in healthy individuals who use their teeth somewhat severely.

While common observation teaches that the development of caries depends in part upon the **susceptibility** of the teeth of certain individuals, this fact has been denied, and apparently with some reason.

Black, of Indiana, subjected a large number of extracted teeth to a great variety of tests, including their exposure for varying periods to the action of chemicals and to the attacks of bacteria. When these teeth were subsequently examined by the most careful methods, there was seen to be practically no difference in the resistance that they had shown. Strong and feeble teeth were affected alike, and it may be inferred that poor teeth do not differ materially from those that are usually regarded as strong in their resistance to the influences that produce decay.

The old opinion that the teeth are injuriously affected through the action of certain acids found in the stomach is also disappearing. Miller, who found more than one hundred varieties of micro-organisms that grew in the mouth or about the teeth, believes that caries is the result of lactic acid produced by the growth of certain of these bacteria. It is now generally accepted that the bacteria are in some way responsible for dental caries; but there is a growing doubt as to lactic or other acids playing any special part in this process. Hopkins, of Harvard, has taken up the question, and has shown that in these micro-organisms, of which he has found about fifty varieties commonly present in diseased teeth, about one-fifth of the number were producers of lactic acid, but the strongest proportion of acid that he was able to produce by the growth of these bacteria was 0.5 per cent. He subsequently found that if teeth, good and poor alike, were subjected to a solution of lactic acid in the strength of 0.5 per cent. for a period of four months, no carious action whatever could be discovered. The observer emphasizes a fact, previously known, that some of the organisms that are apparently destructive give rise to secretions alkaline rather than acid in reaction. It has been commonly observed that some mouths in which caries is conspicuous show a free secretion of saliva and a constant alkaline reaction. Much has yet to be learned about the matter; but it may be assumed that to bacteria we must attribute dental decay; that the question of natural resistance of the teeth plays but a subordinate part; and that the character of the diet, so long as it is sufficiently nutritious, has not been shown to have any influence whatever. When fragments of food, together with the secretions of the mouth, find lodgement between and around the teeth there is afforded an opportunity for the growth and development of bacteria. Some idea of the number of these organisms may be inferred from what has been said. It is believed that micro-organisms are concerned in the formation of the discolored tartar so disfiguring to the teeth and injurious to the gums. But teeth are attacked and cavities are formed without the development of tartar; all that seems necessary is for the organism to find a lodgement in some protected place where they are removed from the action of the tooth-brush and other toilet articles commonly used to dislodge them. Catarrhal irritation about the margin of the gums leads to their recession and exposure of the teeth where they are unprotected by enamel. This catarrhal condition is due in large part to the action of bacteria, but the condition is much favored by the continual irritation from tobacco and acrid foods, also by the presence of tartar and by carelessness in the use of tooth-brushes, tooth-picks, and the like.

A disease of much importance that occasionally affects the gums is known as **pyorrhœa alveolaris**, commonly called Riggs' disease. This was at one time believed to depend upon a constitutional condition, and in some way to be associated with the so-called uric-acid diathesis. This view never seemed logical, and is overthrown by recent study. Undoubtedly, as in the case of other infections, perfect systemic health is the best safeguard against infection, but that good general health can prevent the development of bacteria is untenable. Younger, of Chicago, regards the disease as essentially of bacterial nature, and views injury to the gums, and especially the perforation of the peridental membrane, as the first step in its process. Such injuries are usually produced by the forcible introduction between the gum and tooth of hard foreign bodies, like seeds of berries, bits of bone, and bristles from the tooth-brush.

Preservation of Teeth.—From what has been said it may be concluded that, so far as we understand the matter, the preservation of the teeth resolves itself into a few simple principles; namely, the prevention of overcrowding, the avoidance of chemical or mechanical injury to the teeth and gums, the careful and frequent cleansing of all the exposed surfaces of the teeth, and the use of such harmless antiseptics as will prevent the long continuance of pathogenic bacteria in the mouth. The most easily available means of protection lies in the proper cleansing of the teeth. For this purpose the frequent **use of the tooth-brush** is indispensable. The ordinary bristle brush has been opposed on the ground that it is too hard and is liable to injure the gums, particularly when stray bristles are thrust into the soft parts around the teeth. Brushes of badger's hair, of felt, and of various other substitutes, have been recommended. Most of these contrivances, however, are lacking in the essential resistance and elasticity so important in the thorough dislodgement of foreign matter. The bristle brush in which the bristles are not too closely placed together, thus admitting of their passage between the teeth, is the most practical instrument. Great care should be taken not to allow the bristles to spread, and the brush should be discarded before it is soft or ragged from long use. The brush should not be too broad, and the handle should be bent in the direction of the tuft on the brush so as to admit more easily the reaching of the various curved surfaces of the teeth. The brushing should be practised after each meal and before going to bed, and once daily should be accompanied by the use of a **tooth-powder** sufficiently coarse to produce some grinding and polishing effect. A powder that is too soft or too fine is of little avail. Powdered chalk and orris root are common bases for tooth-powder. Some harmless antiseptic, such as borax, oil of wintergreen, or tincture of myrrh, should be incorporated with the powder to help destroy any colonies of bacteria that may be reached. Twice each week all the exposed surfaces of the teeth should be carefully gone over, and, with the assistance of the tooth-powder, carefully rubbed with a narrow chisel-like piece of a wood that is hard and fine-grained in texture, such as orange-wood, so as to smooth away all the roughness and inequalities. This puts a smooth polish on the teeth and renders their subsequent cleansing by means of the tooth-brush a comparatively simple matter. If this rule were applied in the care of children's teeth, the work of the dentists would be greatly restricted. Of equal importance is the daily use of soft, silk twine, known as dental floss. It should be drawn between the teeth firmly but carefully, so as to remove foreign matter that cannot be reached in other ways. It is important not to cut or irritate the gums nor to loosen their attachments to the teeth. A little experience enables one to accomplish the work deftly and quickly. In the neglect of this practice the teeth can hardly be said to have been cleaned. In addition to these methods, the mouth and teeth should be carefully rinsed every night with some innocuous antiseptic solution. Some of the most harmless antiseptics are powerful germicides, and should be employed to the exclusion of others that may do injury to the general health of the individual as well as to the teeth. Tincture of orris, rose-water, and alcohol in equal parts, flavored with a drop of oil of bitter almond, make a very agreeable **mouth-wash,** and it may be rendered more actively antiseptic by the addition of 0.5 per cent. of formalin.

The importance of the teeth in digestion is not sufficiently recognized. Many cases of chronic indigestion arise from imperfect mastication due to faulty dentition. In all such cases it is of primary importance to have decayed teeth filled, or if there are many missing teeth they should be replaced by artificial ones. Otherwise medication and dietary regulation may be of little avail.

HYGIENE OF THE GASTRO-INTESTINAL TRACT.

The Appetite.—When there is bodily inactivity or mental indolence, as compared with habitual physical or mental exertion, the problems of nutrition must differ widely. The long struggle of the human race to find at all seasons sufficient nourishment to satisfy the demands of life doubtless led to the building up of physiologic laws which made it possible for the organism to undergo periods of starvation, to be followed by periods of repletion. This history of feast and famine must have left to its survivors an appetite that urged its possessor to feats requiring the greatest energy of body and mind; conversely great activity and great expenditure of energy should lead normally to an appetite correspondingly large.

In reviewing the history of organized life, it will be found that appetite has been the great ruling principle that has enabled the living cell to cope successfully with the destructive agents that surrounded it. A good appetite still reminds one of the most necessary factors in our survival, and we instinctively feel that its disappearance or its unnatural perversion is a serious warning of degeneracy or decay. This splendid instinct so necessary for our existence has now more than ever to meet with sudden modifications resulting from the complexity of modern life. While primarily responsible for the discovery of innumerable aliments, the very abundance in this generation, both in quantity and variety, is embarrassing, and we find the results of unnecessary and artificial stimulation in the unnatural desires for food. The lack of attention as to the appropriateness of food subjects not only the digestive apparatus, but all the cells of the individual organism to distress and not infrequently to disease. In this matter the problem to be solved is, first, how to train the appetite into natural and wholesome paths; and, second, how to live so that by means of proper physical, mental, and moral activity there may be successfully oxidized the kind and quantity of nutriment required in normal life, and successfully discharged the waste products that result from the oxidation. It is unsafe to trust the individual to the guidance of the appetite alone, for the reason that this instinct was built up for a condition of existence very different from that which enables the people of this country to indulge themselves to-day. Nevertheless, the appetite is a more reliable guide than speculation, and more trustworthy than a certain narrow scientific view which would select foods along the lines of nutritive values ascertained by chemical experiments. Not that there should be neglect of knowledge as to the calories of energy that may be developed by one substance as compared with another, or the omission of some things that may be learned by rational deduction; but it should never be forgotten that in instinct there is a guide that has been accumulating experience for unknown ages, and that if life in other respects is normal this appetite is likely to lead very nearly in the right direction.

The Effect of the Mind on Nutrition.—These generalities include many specific facts that will bear amplification. In the consideration of the effect of the mental and moral state upon the problems of nutrition there is much food for thought. It is no idle phrase to say that a contented mind, a willing disposition, and a joyous nature give rise to good digestion. It is a truth of such importance that no physician can wholly succeed in relieving derangements of digestion unless he takes this matter into consideration ; in other words, remorse, worry, over-responsibility, petulance, envy, jealousy, and other undesirable mental states give rise to such disturbances, both in primary nutrition and cellular metabolism, that good health is not to be obtained. This explains the fact that a change of scene, a long vacation, and new associations will sometimes improve the digestion and restore health generally when careful dieting and other measures have failed to bring relief. Unenviable mental characteristics may become prominent partly as the result of brain irritation that arises in many unsuspected ways. Such disturbance of the nervous system deranges the appetite, the digestion, and nutrition in general, as well as the mentality.

The Effect of Eye-strain on Nutrition.—One of the most important of these sources of irritation is the continual use of the eyes in all manner of fine work, often in imperfect or wrongly directed light. In the modern system of education, in which children from the kindergarten upward are required to use the eyes closely upon small objects, in association with the concentration of the mind, this evil is found in an aggravated form. As this sacrifice of the ocular apparatus seems demanded by the requirements of education and culture, the nervous system has to undergo the strain as best it may. It has long been recognized that there result headache and various expressions of nervousness, but that the appetite and digestion are also made to suffer are facts that are too little recognized. Whoever carefully looks into this matter will find really that nutrition first shows the result of nerve-strain, no matter from what source arising; and, as a rule, some peculiarity of the primary digestion gives the earliest intimation of the trouble. For instance, there may develop a distaste for certain substances in the dietary; the appetite may become capricious or perverted. Again, a disturbance in motion will arise, and the stomach may contract in a spasmodic, tremulous, or irregular way, while the individual is conscious of disagreeable and sometimes alarming sensations, accompanied with eructations of gas or fluid from the stomach. Or the gastric juice may be secreted irregularly, and in many instances a long chain of dyspeptic symptoms appear without any real disease of the stomach, but merely a disturbance of the nervous system occasioned by improper habits of life. In a certain sense the stomach is acting in the rôle of monitor; but if we are sufficiently wise it may often be regarded as that of the kind mentor. This most common experience may be avoided sometimes by removing the strain to the nervous system, and again by strengthening it by exercise, bathing, recreation, and more hours for sleep and repose. Eye-strain may be lessened or obviated by the wearing of spectacles that are made accurately and adjusted precisely; or by attending to the direction in which light enters the room, or perhaps by prohibiting the use of books printed with small or illegible type. Observance of these precautions may render it unnecessary for the individual to give special attention to his diet; but it is the usual custom at first for the stomach to be considered the source of trouble. As the disagreeable digestive experiences are attributed to the stomach, the fault is commonly supposed to lie in the character of the food, and wiseacres take the responsibility of advising the withdrawal of sugar, fats, or meats, and the abundant taking of oatmeal, grits, and beef-tea, a dietary most likely to undermine resisting power and in the end do infinite harm. For similar relief resort is sometimes had to a milk diet or to abstinence from food, because it is found that the stomach is more comfortable when it has little to do. But this erroneous course will ultimately fail ; it is wiser, when possible, to remove the cause of the difficulty. When it is impracticable to remove the source of worry it becomes necessary to modify the diet, and it is a compromise of this sort that unfortunately we must sometimes make.

Regulation of Meals.—When required to adapt the diet to a tired nervous system and an irritable stomach it must be so managed that the most hearty meal should be taken at a time when it is possible for the individual to enjoy the greatest physical and mental composure, and there should not be demanded too much of the digestive organs when it is known that unusual taxation of the nervous system has been experienced. It is not generally wise in such cases to take a hearty breakfast before functional activity is sufficiently aroused ; nor is it well to allow the chief meal at midday, when the energy is likely to be taxed by work or study. It is better to wait until late in the afternoon, when, after a little rest, the chief meal should be taken—and taken slowly, composedly, and cheerfully. Following this there should be spent a few hours in quiet enjoyment before going to bed.

This rule will seem like an absurdity to many who insist that the late dinner is in itself the sure forerunner of a bad night. This is usually true only when the midday meal has been too hearty. A delicate digestion may be overtaxed by requiring the stomach to muster all its forces too frequently in a given time. It is better economy to accept from the organism a moderate display of energy in the morning, and very slight at midday ; but at evening, when the tissues demand food and when the physiologic appetite has appeared, it may be expected that the digestion will perform its greatest work unincumbered by worries—muscular and mental activities that are likely to draw the blood away from the organs of digestion and to dissipate vital energy in too many ways at one time. If this principle is true, there is no reason why it may not apply to children as well as to adults. Of course, this need not be construed too literally in cases of sturdy and hungry little folks, who are always ready to eat. The application of the rule should be in proportion to the delicacy of the child ; but it must be remembered that the food for the child should be that which is quickly disposed of, and therefore a greater frequency of meals is usually permissible. In fact, it is not safe to use an invariable law as to the frequency of meals in persons of any age, but regularity should be insisted upon. Convention is too often the arbiter in the matter, and the hours for eating are appointed without reasonable regard to physiologic requirements. Nevertheless, the rule given above may be taken as an illustration that is applicable to the majority of mankind. It does not mean that the average man has a weak digestion, but it means that he is overtaxed in a general way, and that if he does not devote some thought to the character of his meals and to the hour for his repasts, then he is likely to develop, first, consciousness of the act of digestion, and, later, distress during the process.

Regulation of the Diet.—It is frequently asked what should be the character of the food taken. The answer must at first be as general as the question; and it may be said that the digestion may be taxed either in the quantity or the quality of food, and in direct ratio with the resisting power and vital energy of the individual. The climate and occupation must also be considered. A stalwart wood-chopper requires in the winter large meals rich in fats and carbohydrates, which, in the process of oxidation, produce relatively a large amount of heat, and albumins that more directly nourish the muscles and nerves. With such a worker, so long as there is sufficient nutritive value in the food, great attention need not be paid to its variety, nor even to its digestibility. For instance, certain woodsmen crave a very resisting form of pastry because it "stays by" and does not too quickly leave the stomach empty. For such persons the hastily prepared oatmeal-porridge is suitable, because it is slow to digest.

For the sedentary and indolent person the supply of food should be small and digestible. For the sedentary brain-worker the amount taken should be increased in proportion to his mental activity, and it should be easily digestible and very nutritious. In a cold climate, as is generally known, large amounts of fats are required, while in hot climates the carbohydrates and fruits seem to be demanded by the organism.

For the ordinary business or professional man, or the student, a **breakfast** may be advised to consist of one or two soft-boiled eggs or an omelet, a piece of bacon or fish, a roll or some toast, and one cup of coffee. Oatmeal-pudding is unsuitable, because it is rarely well mixed with saliva, but is hurriedly bolted, deglutition being facilitated by the covering of cream. The same may be said of other "cereals," except those that are partially dextrinized by previous cooking in the process of manufacture. Early in the morning at least a glassful of pure water, neither iced nor hot, should be taken.

If the breakfast hour is at eight, the **luncheon** hour should be at one. Milk is an excellent aliment for this meal. It disagrees with some, but this is usually because other foods are taken with it. Milk is not to be regarded as a drink, but as a food. It is best taken alone, but it generally agrees better if a certain amount of starchy food is taken at the same time, although the latter should be carefully masticated and insalivated, and should neither be saturated with milk nor washed down by it. Milk should be drank and bread eaten slowly. The object of this is to take advantage of the action of the saliva in converting starch into maltose. For those who dislike milk, or with whom it does not agree, the luncheon may consist of broth or light soup, bread and butter, a few oysters, sweetbread or stewed lobster, and perhaps a little farinaceous pudding like corn-starch, thoroughly prepared rice, or tapioca. Of such a luncheon fruit may form a part, or fruit may be taken before breakfast, and rarely after dinner. With such an arrangement, dinner should be taken at six or thereabouts. This meal should be as much as possible served slowly in courses. The conventional arrangement of the courses at dinner is a desirable one, and is apparently the result of the experience of ages. The preliminary course of a good soup that is not too rich, to be followed by fish, then a joint or roast, with one or two vegetables, a small salad, bread, and some simple dessert constitute a typical dinner, and in amount should be sufficient to make up for the somewhat scanty meals that preceded it.

The digestion is usually taxed in proportion to the variety of the foods taken; therefore, when the stomach reacts unfavorably to an extended meal, food should be limited—first in variety, and second in quantity. The precise amount to be taken during all these meals is a matter that must depend upon individual requirements. As a rule, more food is taken than necessary; but there is a large class of nervous people who eat regularly, but rarely take a sufficient amount of really nourishing foods to replace that which is lost by waste.

The following table is given by Parkes as showing the amount of food required by a healthy adult in 24 hours (see page 383):

	In laborious occupation.		At rest.
Nitrogenous substances—*e. g.* flesh . .	6.0 to	7.0 oz. av.	2.5 oz. av.
Fats	3.5 "	4.5 "	1.0 "
Carbohydrates	16.0 "	18.0 "	12.0 "
Salts	1.2 "	1.5 "	0.5 "
	26.7 to	31.0 oz. av.	16.0 oz. av.

To this should be added from fifty to eighty ounces of fluid.

In the arrangement of meals above described the requirements of the average brain-worker have been in mind. In some cases a heartier breakfast will be demanded, and with others a certain amount of lassitude and depression may occur late in the afternoon when only a light luncheon has been taken. If the latter complaint is made, relief may be had by allowing a cup of tea and a cracker to be taken at four o'clock. Drank at this time, tea rarely disturbs sleep, and it is not likely to blunt the appetite for dinner. Some individuals have naturally a rapid digestion, and a sense of hunger is experienced toward bedtime. In such an event it is best that a little simple food be taken. Only those who have vigorous constitutions can indulge at night in "lobster à la Newburgh," rarebit, and the various other savory and rich preparations that the use of the chafing-dish has made popular. This is not an argument against eating before going to bed, but merely an instance of the imprudence of taking food unsuited to the individual or to the occasion. It must not be supposed that the dietary cannot be varied, for there is no doubt that monotony in daily living is bad hygiene.

Proper Cooking.—Many articles of diet that are considered unwholesome are usually so merely because they are badly prepared. Hardly too much can be said in favor of scientific cooking, and that most important article of diet, **bread,** is most often open to criticism. Really well-baked, sweet, crisp, "nutty" bread is regularly found only in exceptional households. Indeed, many people do not seem to know what "good bread" means. Much of the tirade against potatoes is unjust, and results from ignorance in their preparation or the prejudice of certain writers. A great variety of green vegetables that are not only palatable but fairly nutritious, and some of the constituents of which are necessary because they contain acids, salts, and extractive matters required by the economy, are easily enough digested when they are well prepared. Aside from their nutritive value, they are useful in making more bulky the contents of the alimentary canal, thus favoring the action of the stomach and intestines, whereby constipation is avoided and a healthy state of the intestinal mucous membrane is favored.

Fruits.—It is rarely necessary to urge Americans to eat fruit; they too often err in taking too much. It is not uncommon in this country for people to eat fruit at any time during the day or evening. The benefits from eating fruits are undoubted; they act upon the digestive organs somewhat like the green vegetables, but they have other advantages from the acids contained, and also because they appeal to the esthetic sense. The eating of fruit before breakfast is unobjectionable in most instances. Fruit may also properly form a part of the luncheon and dessert, but it should not be eaten between meals. The harm in eating fruit may lie in its excessive use, or in eating that which is unsound or unripe.

Coffee, tea, and cocoa have their place in normal diet; and while they occasionally are the source of much disturbance, it is generally true because of over-indulgence in them. As a rule, coffee and tea are taken in excess, and, on the whole, do more harm than good. The plea is made for the temperate use of these substances that have come to be almost necessities of the human race. After the morning bath a small cup of coffee, gently stimulating the circulation and the motor function of the alimentary tract, and apparently making more available the energy accumulated during the night's rest, generally accomplishes good. The use of tea in the afternoon has been pointed out. Both coffee and tea, particularly the latter, antagonize the action of the saliva upon starch, and, therefore, taken in excess may retard digestion. There will ensue little trouble if bread is sufficiently well masticated and if no drink be taken while eating. The saliva passing with the food into the stomach stimulates the secretion of that organ, and therefore indirectly assists in the digestion of the albumins. This is another reason why careful habits in eating should be inculcated early in life.

Sugar contains much stored-up energy, and is a useful article of diet; but if taken early in the meal, it lessens the appetite and embarrasses digestion.

The action of condiments is quite varied. Most of them appeal to the sense of taste, and act as local salivary and gastric stimulants. The high seasoning of food not only depresses the sense of taste for simpler foods, but also exercises a harmful influence in irritating the gastric and intestinal mucous membranes and the liver.

Fats and oils should be included in every rational dietary. Even in warm climates these substances have always formed an important item in the foods that are selected by choice. It is difficult to explain the fact that they are disliked by some children, although the health may be failing for the want of them. In such cases evident improvement is observed when fats are prescribed by the physician. Fats should not be taken before or early in the meal, for the reason that they are supposed to protect the mucous membrane of the stomach from its normal stimulation by the other foods, and thus tend to lessen the secretion and motion of that organ. If fats are taken late in the meal or following it, they do not disturb digestion unless fermentation occurs. While in the stomach the delicate envelopes of the fat-cells are broken, when they pass with the chyme into the intestine and are absorbed by the lacteals in the villi. Intestinal digestion of fats seems to be merely that of the splitting up of the fat-cells, a process of emulsification that is for the most part accomplished by the action of the pancreatic juice, assisted by the secretions of the liver and duodenum. Quantities of minute particles of fat thus subdivided are to be found in the lacteals during intestinal digestion, and they subsequently appear in the blood, from which the tissue-cells readily appropriate them. It will thus be seen that the assimilation of fats is a simpler process than that attending the albuminoids, starches, and sugars; and to suppose that fats are unwholesome is an erroneous conclusion, probably based upon the fact that when incorporated with starches and sugar in the form of pastries, etc., they are likely to disturb digestion. This is true for the reason that the starch-cells are protected by the fats from the action of the saliva in the mouth and stomach and from the action of the pancreatic juice in the intestine; and for the further reason that the fats are often superheated in cooking, thus giving rise to indigestible and irritating fatty acids.

The salts compose an important part of the diet, and occur as various combinations of sodium, potassium, lime, magnesium, and ammonium. Of these, the most important is sodium chlorid, or common salt, which makes up 5.5 + parts in every 1000 parts of the plasma of the blood, and occurs everywhere in the body except in the enamel. A sufficient amount is not derived from unseasoned foods, and therefore the use of salt as a condiment is universal. Some of its derivatives, of which hydrochloric acid is the chief, form a most important constituent of the gastric juice; and it seems reasonable that salt should be taken in connection with the albuminoids, with which the gastric juice has most to do in the process of digestion. Salt may be taken in excess when salted meats form the chief aliment or when an unnatural habit of eating salt is acquired. But if one is deprived of salt there is not only a disturbance in the cellular nutrition, but also a depreciation in the gastric juice.

Drinking Water.—The question of drinking water is one that requires some consideration. As has been stated, about eighty ounces of fluid should be taken daily. This includes that which is taken in combination with solid foods. Most people leading sedentary lives take too little water, and also err in taking it for the most part when eating. A certain amount of water always should form a part of every meal, and particularly is it necessary in those who have very active digestion. It assists the escape from the stomach of those substances made soluble by the action of the gastric juice and the churning effect of the stomach, and will sometimes make digestion comfortable when it otherwise would be attended with distress. But while it is allowable for water to be taken with meals, it again should be repeated that the food should not be washed down. Such a practice not only interferes with starch digestion, but it also enables the individual to swallow morsels of food altogether too large and resisting for the stomach to manage comfortably. The proper time for taking the bulk of the fluid is between meals, particularly early in the morning and late at night. It is a fact well known to physicians that women especially drink too little water; the habit probably results from the inconvenience attending the taking of the proper amount. While a person may be saved some embarrassment by this kind of denial, positive harm usually results from the continuance of the practice. The American habit of drinking **ice-water** has been much censured. It is unnatural, and in some instances harm may be traced directly to it. In many no injurious effect appears to follow its use. This must be said in its favor, that those who enjoy cold drinks are likely to take sufficient water, which is not true of the ordinary individual.

Harm comes from the practice of drinking **hot water** in the false belief that it prevents or cures dyspepsia. Doubtless hot water has its place, and it is to be recommended rather as a remedy than as a daily usage.

Alcoholic Beverages.—In general it may be said that alcohol is unnecessary; and, aside from the vicious results of inebriety, it sometimes is capable of producing disturbances of digestion. This is particularly true in those unaccustomed to its use, and is truer of beer and wines than of the distilled liquors, except when they are used too freely. With the continued use of alcohol in any form it is possible so to disturb the nervous system that nausea, loss of appetite, and other functional disturbances arise; and if the practice is still further continued congestion and catarrh of the stomach and irritation of the liver may be expected. These facts are, of course, universally accepted; but the question is how much may digestion be harmed from the taking of a small amount of wine or spirit as a part of an occasional feast or as a regular accompaniment of dinner. While it is a fact that wines and beers rich in extractive matters interfere with gastric digestion, it must be admitted that unpleasant effects are not usually experienced in temperate people, particularly when they are active in mind and body. Certain individuals are always the worse from even the temperate use of alcohol, tobacco, tea, or coffee; and such individuals should also abandon chocolate and cocoa. These persons are exceptional, however, and in the case of the ordinary man, leading an active life, a moderate amount of alcohol may be taken without harm. Unfortunately, moderation is not satisfactory, and deplorable results may arise that are apparently traceable to the gradually increasing use of alcohol.

Other Stimulants.—It is held by certain authors that stimulants of all kinds should be avoided, which would put the ban of exclusion upon condiments, spices, hot foods, ice, and carbonated drinks, as well as upon tea, coffee, cocoa, and alcohol. But this position is not logical, for it can be shown that the digestive apparatus is stimulated on the one hand and depressed on the other by equally potent factors that cannot be excluded; for instance, by constantly occurring emotional states as well as by recreation, exertion, and fatigue. The latter group will be considered as merely physiologic influences, and therefore not open to criticism; but this conclusion is not altogether true. Certain mental states result in interference with digestion to such an extent that the appetite may be lost, nausea induced, the gastric secretion interrupted, and the movements of the stomach and intestine depressed, or irregular and spasmodic movements induced which lead to the upward discharge of gas from the stomach and perhaps regurgitation or vomiting of the undigested food; or there may be developed such severe contraction of the gastric muscles that pain is induced. The same causes very frequently induce gastric distress and occasional neuralgia. On the other hand, in tempting displays, agreeable zests, and appetizing odors, we have instances of stimulants that as often lead to excess in eating as they do to increased activity in digestion. A curious phenomenon is the overdistention of the stomach and intestine with gas which apparently does not arise from fermentation, but appears to be abnormally secreted in the stomach and bowels. Under such conditions a gentle stimulant will enable the digestive organs to regain their equilibrium, after which a small amount of fluid food might be easily managed. These are the cases for a cup of tea or coffee, or a posset of aromatic herbs, and those who have no moral scruples against its use may be quickly relieved by a thimbleful of brandy.

Eating after Bathing.—A similar state of depression of the digestive organs may result from a too prolonged bath ; and the popular opinion that it is unsafe to eat after bathing is based upon the fact that functional energy is for the time being apparently diminished, and in some people digestion is thereby interrupted. This fact does not apply to all alike, but it is true with sufficient frequency to give rise to the popular belief.

Eating after Exercise.—Physical exertion is more likely to disturb digestion than bathing. Its effect upon the digestion is similar to that produced by mental fatigue. Singularly enough, this fact has not been universally recognized ; and it is common for people who are physically exhausted from tennis-playing, bicycling, and other violent exercises to indulge themselves in a hearty repast without having previously rested. Most people understand that it is unsafe to undergo vigorous exercise directly after a meal ; but they do not realize the mistake of eating heartily when too tired. These truths apply more to those who are untrained and unaccustomed to physical strain ; but athletes have discovered that it is not wise to eat heartily when about to engage in great exertion. Flint found that during a period in which the pedestrian Weston walked a total of 317 miles in 5 days, he consumed on an average about 83 grammes of proteids daily. Yet in the diet of an ordinary farmer or mechanic in this country about 100 grammes of proteids are taken during 24 hours. Of course, other forms of food besides proteids are taken, and much energy is derived from the combustion of the fats and carbohydrates. As a rule, a well-trained man who is carrying on for a prolonged period unusual physical effort is able to eat and digest more food than the ordinary man. The disproportion between the nutriment taken and the energy expended may be approximately ascertained by noting the change in the weight of the body. A. P. Bryant states that Sandow's daily diet contains 244 grammes of proteids, which supplied 4460 calories of energy. Under great strain more proteid is required than under conditions of normal exercises; but when the strain is to be short and severe it is wise to retrench at the table lest there should succeed rebellion in the stomach.

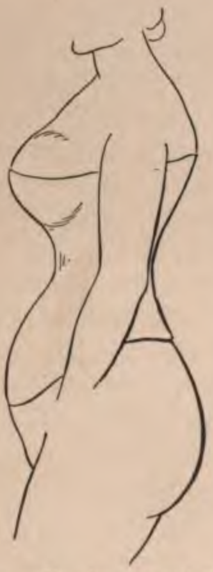

FIG. 7.—Showing constriction of the abdomen and, necessarily, the displacement of the abdominal viscera, produced by an improper corset.

Influence of Carriage and Dress on Digestion.—Abnormal conditions of the liver are for the most part secondary to disorders of the stomach and intestines, and in cases in which there is derangement of the primæ viæ it is usually safe to conclude that the liver is also out of condition. One of the most common causes of sluggishness in hepatic circulation and secretion, as well as of the disturbances of the intestines and other portions of the digestive apparatus, may be attributed to faulty carriage of the body and relaxation of the abdominal muscles, lessening of the abdominal type of respiration, and consequently the loss of diaphragmatic motion. All of these conditions are very much aggravated, and some of them are directly induced, by the improper dress almost universally adopted by women, and to some extent by children. In illustration may be instanced a woman who is said to dress loosely. With her corset removed she is found to measure twenty-seven inches around the waist, but as ordinarily dressed she measures twenty-one inches around the waist outside the garments (Fig. 7).

For the correct performance of function on the part of the stomach, liver, and intestines it is necessary that free and properly related movements of these organs should take place. Such movements are impossible in the large majority of women. The defects are so common, and the deformities of the body necessarily associated with them begin so early in life, that they are largely overlooked, and are argued to be natural and beautiful by the mass of womankind. A certain amount of intra-abdominal pressure is necessary if the viscera of that region are to be held in their proper places and proper relations. This is possible only when the body is erect in sitting and standing, when the chest is kept habitually raised to its normal position, and when the abdominal muscles are strong, and are not allowed to relax, pouch out, and thus favor the descent of the organs (Fig. 8). This position should be urged during childhood, and mothers should be instructed in the proper method of dressing their children so that the chest may have the freest motion without meeting with opposition from the clothing. All garments should be suspended from the shoulders, to prevent the downward displacement of the stomach, intestines, kidneys, liver, etc. Practically all women stand in an improper attitude, a fact of which they are apparently ignorant. Others would not remain ignorant of the fact but for the concealment attending women's dress. That this is no exaggeration, every physician who has given the subject careful study

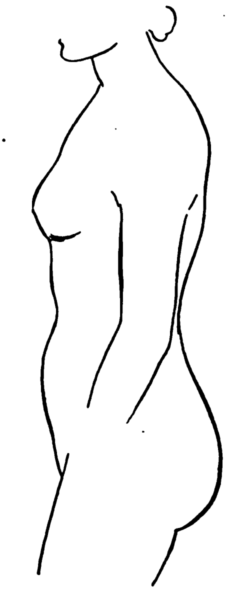

FIG. 8.—Showing the shape of the abdomen in a well-developed woman standing in the correct posture.

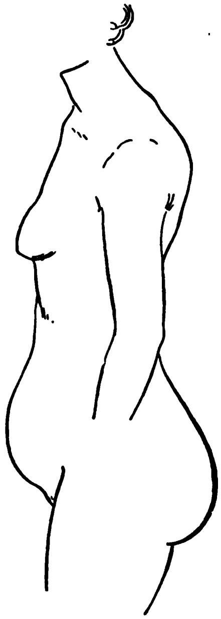

FIG. 9.—Showing the shape of the abdomen and the contours of the body in a well-developed case of enteroptosis.

will readily agree; but the fact that more than 50 per cent. of all civilized women, in all classes of life, have developed the condition known as **enteroptosis** (Fig. 9), which means that the stomach, intestines, very often the kidneys, and sometimes the liver, are dragged downward and remain permanently out of their proper position, is not generally known. Such, however, is the case; and this condition more than any other cause is responsible for the constipation, backache, debility, biliousness, early loss of complexion, headache, and that long list of ailments of which so many women in all civilized countries are victims. Those who have vigorous constitutions, strong nervous systems, and who keep the body in a healthy tone by leading out-of-door lives and avoid the common habits of worry and petulance, may live with moderate comfort even though suffering from the enteroptosis made necessary and permanent by the methods of dress. But the greater proportion of women lack these sturdy qualities, and therefore suffer more or less from the symptoms described. Furthermore, this downward dragging of the abdominal organs leads to displacements and derangements of the pelvic organs, and the genito-urinary diseases so common in women are a natural result. In young children the intestines have not yet assumed that position which is normal in adult life, and in some this lack of development makes a constant difficulty in evacuation of the bowels. By a slow process, and in the absence of interference, these matters in time right themselves; but not infrequently the child is so handicapped through the want of out-of-door sports, adequate physical training, and proper methods of dress that the large intestine never assumes its proper place.

Constipation and Diarrhea.—Downward displacement of the bowels not only leads to constipation, but it also favors a catarrhal state of the intestinal lining, leads to intestinal indigestion, and occasionally produces diarrhea, and sometimes pain and the discharge of mucus with the feces. There are other reasons aside from displacement that commonly give rise to constipation and other unhealthy conditions of the intestines, important among which are diet and habit.

Influence of Diet.—It has been said that the cellulose of fruits and vegetables exercises a wholesome influence upon the intestinal mucous membrane, increasing the bulk of the contents and stimulating the activity of the secretions of the intestinal glands and the contraction of the intestinal muscles. Formerly, when the use of coarser foods was more common than at present, when flour and meal were less carefully bolted, constipation is said to have been less common. For these reasons it is often advised that those who suffer from constipation should confine themselves to coarse and bulky foods. It is true that such a diet is beneficial to one class of people, but it is harmful to another. When it happens that the mucous membrane of the intestine is less than normally irritable, when the unstriped muscle-tissue is so quiescent that it fails to contract from the stimulus offered by soft and semifluid contents, it is found that both the secretion and motion of the part are so diminished that there is slowing of the intestinal stream, and an evacuation does not occur until there is a considerable accumulation in the colon. Under such conditions the bowel is usually successful in emptying itself unassisted, but only irregularly and after improper delay. Such stagnation of the intestinal stream is injurious to the intestine and to the organism. To the former, because of the undisturbed harboring of micro-organisms, the dulling of the normal irritability of the motor and secretory nerves, and the weakening of the intestinal muscle; to the latter, because of the absorption from the intestine of certain toxic substances that are much more likely to be formed when the intestine is inactive. These toxic substances, finding their way, first, to the liver and then to the general circulation, develop those symptoms that are commonly recognized under the name of **biliousness.** This term has come to have a broad meaning, which, indeed, is necessary, as the expressions of this form of auto-intoxication are varied. It will be understood how a coarse diet may be very serviceable in relieving the condition described above. But there is another and nearly as large a class in which the mucous membrane and muscle of the intestine are too irritable. This results sometimes from a low grade of inflammation affecting the superficial lining of the intestine, and sometimes to over-impressionability of the nerves of the part. Under such circumstances a bland, unstimulating diet results in intestinal contents that excite the irritable bowel to proper activity; but if the food is coarser and contains much vegetable fibers or husks of grain it causes so much mechanical irritation that the intestine contracts spasmodically and prevents the normal onward movement of the feces. These influences may so disturb the part that over-secretion and over-motion result, and a diarrhea follows, usually to be succeeded by constipation, and it in turn by diarrhea. The physical condition accompanying either one of these states may not be so unlike those accompanying the other; and whatever course of living most tends to regularity is equally useful in the prevention of diarrhea and constipation. It so happens that there is no one diet that is suitable to all cases of constipation. For the ordinary individual it is a mistake to restrict the diet to over-refined and highly nutritious foods; nor should the other extreme be followed. A correct blending of coarse and fine foods, with the proper proportionment of meats, vegetables, fruits, fats, starches, and sugars, is the diet most likely to agree with the intestine as well as the stomach.

The influence of habit is equally important in evacuating the bowels as it is in the matter of eating. The habit of having a regular daily movement after the morning meal should be cultivated. Irregularity in defecation, usually the result of postponement because of inconvenience, is one of the most successful means of inducing constipation, hemorrhoids, and other unnatural states of the intestine. Few realize that the digestive apparatus is under a sensitive nervous control, and does not tolerate unphysiologic treatment without most appreciable resentment. While infrequency in defecation is evidently harmful, over-frequency is also to be condemned. For the colon to contract naturally and successfully it should have a certain amount of contents of a sufficient consistency. Such conditions stimulate a regular and progressive contraction of the bowels and a successful result. In children the amount of effort put forth, the time required for defecation, and the form, quantity, and character of the evacuation should be carefully observed. The dejections are normally more frequent in the young than in the adult. Yet even in children the habit of going to stool several times during the day should be discouraged. There is a certain rhythm necessary in most physiologic processes, and this is so true of the digestive tract that disregard of the impulse for physiologic defecation is to establish irregularity and usually suffering.

HYGIENE OF THE SKIN AND ITS APPENDAGES.

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ANATOMY AND PHYSIOLOGY.

THE skin is composed of two layers, a superficial thin layer, called the epidermis or cuticle, and a deep layer, known as the derma cutis or true skin.

The epidermis is readily separable from the derma, and is the portion of skin that is raised by the fluid of an ordinary blister. Its chief function is to give protection to the underlying true skin and to prevent it from drying and losing its natural softness and pliability. The epidermis has little or no sensibility, and in this respect differs from the true skin, which is remarkably sensitive from the presence of many delicate nerve-endings. The deeper layer of the epidermis consists of cells which are polygonal in shape and moist in character, and is called the mucous layer or rete mucosum. The superficial cells are dry and flattened, and constitute the horny layer of the epidermis. There is a constant production of new cells in the epidermis taking the place of other cells, which are pushed toward the surface and finally shed by the skin. This process of shedding the superficial dry scales is constantly taking place, and is aided by the rubbing of the clothing against the skin and by the friction employed in bathing. This desquamation takes place in the form of minute scales. Only upon the scalp do they tend to become visible to the eye and appear as flakes, forming a condition commonly known as dandruff. This physiologic shedding of the epidermis when not in excess is to be aided by bathing the skin and shampooing and brushing the scalp.

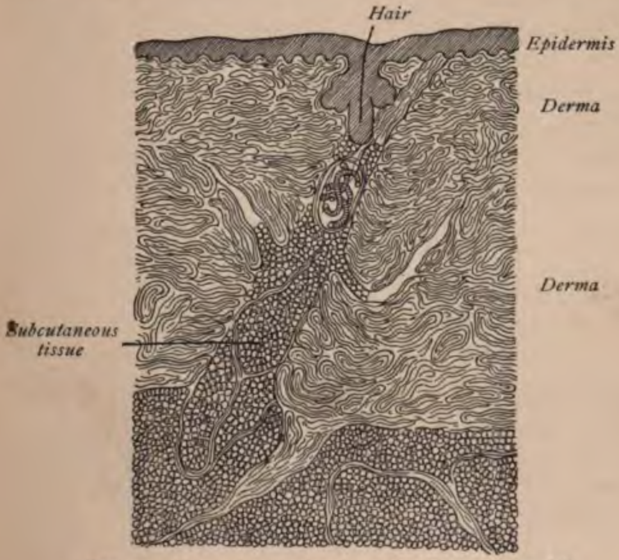

FIG. 10.—Vertical microscopic section through the skin.

In the deep portion of the mucous layer of the epidermis is situated the **pigment,** which is the cause of the color of the skin. There is an old adage that "color is only skin deep," but in fact color is only one-half skin deep. The various colors of the skin of the different races of mankind are due to the varying amount of pigment in the deep layer of the epidermis. Under the influence of the sun's rays pigment seems to be most readily produced. Not only are races living in the tropics as a rule much darker than the inhabitants of a cold climate, but in this temperate climate is noticed, in the form of tan and freckles, an increased production of pigment occuring in summer. Occasionally the function of forming pigments ceases, and the diseases known as vitiligo and albinism result. **Vitiligo** is characterized by white spots, most frequently seen on the backs of the hands, while the condition known as **albinism** consists of a total absence of pigment in the skin, hair, and eyes. The opposite condition, however, is more common, namely, the production of too much pigment, as seen in the formation of **freckles** and the so-called "liver spots" or "moth patches."

The True Skin (Derma).—The under surface of the epidermis is uneven and dips down between the prominences of the derma known as papillæ. The true skin is the organ of sensation, and the nerve-endings giving rise to sensations of touch, pain, and temperature are contained in these little hillocks or papillæ. The deeper parts of the skin, together with the underlying fat, serve as a protection to the body against violence.

The glands in the skin are of two systems—the perspiratory and the sebaceous or oil-producing.

The perspiratory glands consist of little tubes ending in coils lying deep in the true skin or in the fat beneath. An outlet or duct runs in a spiral manner to the free surface of the skin. These glands, or pores, as they are popularly termed, are found everywhere on the surface of the body and are present in very great numbers. It has been calculated that the entire number of glands, if placed end to end, would cover a distance of twenty-eight miles. Next to the kidneys the perspiratory glands are the chief means of removing water from the system, and in addition carry away various other waste-products. Besides being an organ of excretion, the skin, by means of its pores or perspiratory glands, performs the important function of regulation of the body-temperature.

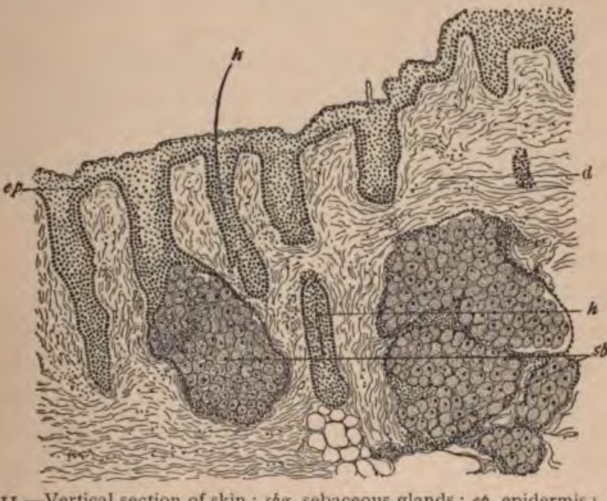

FIG. 11.—Vertical section of skin : *sbg*, sebaceous glands ; *ep*, epidermis ; *h*, hair ; *d*, derma.

When the body is at rest or only slightly in motion perspiration is constantly taking place in the form of a vapor, and is spoken of as being insensible. When, however, considerable exercise is taken the pores become more active and produce a visible amount of perspiration, which is termed sensible. The condition of the atmosphere greatly influences the activity of the glands. If the air is saturated with moisture, the perspiration does not readily evaporate, but remains upon the body. If the air is dry, and especially in motion, the perspiration readily evaporates and becomes insensible.

When the surrounding air is much warmer than the body the vessels of the skin dilate, free perspiration takes place, and by its evaporation the body becomes cooled. If the air is already full of moisture, evaporation of the perspiration becomes very difficult, and we suffer more from heat than if the air were dry. This phenomenon of finding hot weather most uncomfortable when humidity is present is known to all through disagreeable experience. It is for the same reason that a much higher temperature can be born in the Turkish bath where the air is dry than in the hot vapor or Russian bath.

When the air is cooler than the body the blood-vessels contract and retain the warmth of the body by lessening the amount of blood in the skin to be cooled. Considering the purposes subserved by the perspiratory glands, it is highly important to remove the dry scales of the epidermis which constantly accumulate and interfere with their free action. While this is partially accomplished by the friction of the clothing, nothing will take the place of systematic bathing if we desire to keep the skin in a perfectly healthy condition.

While the perspiratory glands give out moisture, it is not probable that they absorb any appreciable amount of water from without, as experiments attempting to show an increase of weight after long-continued immersion in water have proved inconclusive. The same is true of salt in solution, and the efficacy of sea-bathing in giving and maintaining health and vigor is due to causes other than the absorption of salt.

The oil-producing or sebaceous glands are found in all parts of the skin, with the exception of the palms and soles, and are especially abundant on the face. Under the microscope they appear like small sacs situated more superficially than the perspiratory glands, and opening in most cases into the little pits for the hairs known as the hair-follicles. They secrete a greasy substance, for the purpose of lubricating the skin and keeping it in a soft and pliable condition. The special oil-glands of the eyelids prevent adhesion of the lids, while those in the scalp form a natural hair oil or pomatum. The oil-glands prevent injurious friction of opposing surfaces, and the oily secretion in general tends to protect the body from moisture, as it does in the case of feathered creatures.

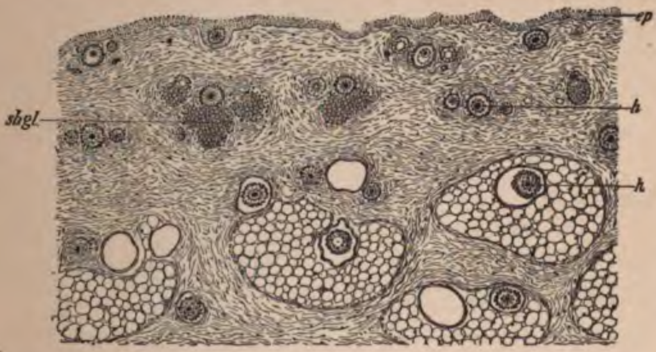

FIG. 12.—Transverse section of skin from scalp, showing hairs cut transversely: *ep*, epidermis; *h*, hairs; *sbgl*, sebaceous glands.

Although the hair and nails appear to be entirely different in structure from the skin, they are merely modifications of its horny layer.

The hair consists of a shaft which appears above the surface of the skin, and a root which is placed in a socket or inversion of the skin, called the **hair-follicle.** At the bottom of the follicle the hair and the various layers of the skin are found to be

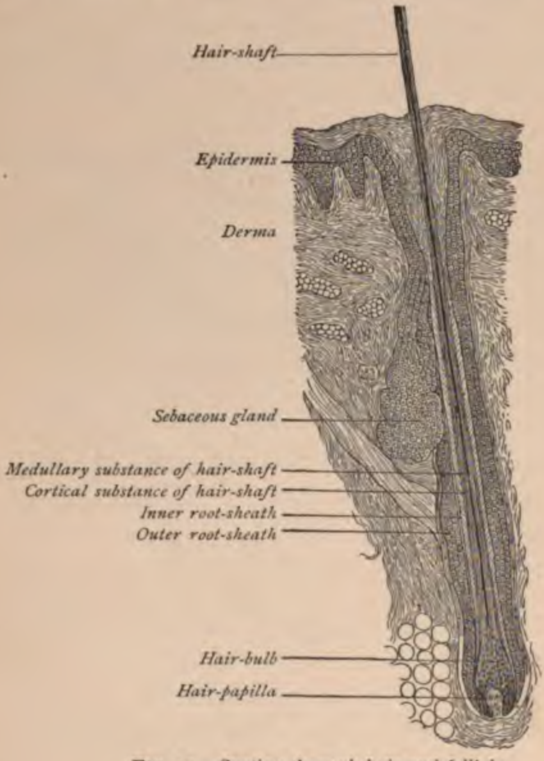

FIG. 13.—Section through hair and follicle.

continuous. The substance of the hair consists of three different layers, and has been compared to the trunk of a tree. The main portion of the hair, the fibrous portion, is comparable to the dense wood of the tree, and consists of flattened and elongated cells. It constitutes the main bulk of the hair. The central portion, or pith, consists of cells nearly spherical in shape. The outermost layer of the hair consists of flat cells which overlap one another like tiles on a roof, and to this fact is due the rough feeling when a hair is pulled between the fingers from the point toward the root. The property of "felting" is also due to this peculiar saw-like surface of hair. By the same arrangement a loose hair may at times work its way into a wound.

The color of hair depends upon the presence of pigment in the pith and fibrous layer, and upon the presence of minute bubbles of air. The greater part of the body is covered with fine, downy hairs, whose roots extend but a short distance in the skin, while the roots of the large stiff hairs extend into the fat beneath the skin.

The hair serves various useful purposes, besides being a very great adornment to the human body. It protects the head against the sun's rays and against violence, and affords a very considerable amount of warmth. The eyelashes protect the eyes against the entrance of foreign matters, and the stiff hairs of the ear and nose prevent intrusion of insects and foreign bodies. The moustache is supposed to act as a filter of the air that is breathed, while the beard is said to serve the purpose of protecting the throat from cold.

The nail consists of modified horny tissue lying upon the nail-bed, which is a portion of the true skin. The nail itself corresponds to the epidermis in this region. The sides and root of the nail are embedded in folds of skin, while its end is free. Near the root of the nail is seen a semilunar area, which is more opaque than the rest of the nail, due to a scarcity of blood-vessels in this situation.

The nail itself has no color and is bloodless. Its apparent color is due entirely to the vascularity of the nail-bed beneath, which shines through the translucent substance. The growth of the nail takes place at its root by constant formation of new cells pushing the nail forward. If, however, an obstacle to its forward growth is offered by a tight-fitting shoe sooner or later the nails will begin to grow into the flesh, and the painful condition of ingrowing nail will be the result.

The discussion of the hygiene of the skin naturally involves a number of important subjects, prominent among which are food, exercise, bathing and clothing. As food and exercise are treated elsewhere in this work, it need only be mentioned here that the maintenance of the skin in a healthful condition depends largely upon a judicious dietary and systematic exercise, while the attention of the reader is particularly invited to the subjects of regular bathing and proper clothing.

BATHING.

While discussing the physiology of the skin it was shown how the superficial scales of the epidermis tend to collect, and with the sebaceous matter and dirt to form a pellicle which interferes with the proper functions of the perspiratory glands. Bathing removes this pellicle and is an important factor in maintaining a healthy skin. In addition it has a very beneficial effect upon the general health, as the skin is intimately connected with the internal organs by means of the nervous system.

Classification of Baths.—Baths are often spoken of as local or general, according as the ablution is confined to a portion or the whole of the body. Again, they may be classified according to temperature as follows: hot, over 98°F; warm, between 90° and 98° F.; tepid, between 80° and 90° F.; cool, between 65° and 80° F.; and cold, below 65° F. These are merely arbitrary, but convenient distinctions. For practical purposes it will be sufficient to describe the cold, the warm, and the tepid bath.

The cold bath is intended to act as a stimulant and give strength, as opposed to the warm bath, which has a soothing action, or, technically speaking, is sedative. The proper time to take a cold bath is before breakfast and as soon after rising as convenient. A simple and by no means ineffective way of taking the morning bath is with the sponge, for the conveniences of a shower bath or tub are not always at hand. Every one, however, may possess a sponge and a bowl of cold water, and will derive health and enjoyment from their daily use. Considering the fact that cold baths are so beneficial and pleasant, as those who take them regularly will affirm, it seems strange that in this country at least such a small number of persons indulge in them. Many say that they cannot take the cold bath, as it gives them too great a shock, or is too weakening, or is not followed by a proper reaction. On the contrary, however, most persons can take a cold bath every morning if they will only make up their minds to do so and go about it properly. It would not, of course, be advisable for one advanced in years, when the blood-vessels are naturally weak, to risk apoplexy by plunging into a cold bath without being properly trained to it by gradual stages.

The physiologic action of the cold bath is to contract the cutaneous vessels and to drive the blood to the internal organs, causing a pallor of the skin. The respiration is greatly increased in depth, quickened at first and then slowed. The frequency of the pulse is lessened and the temperature somewhat lowered. The nervous system and especially the mental faculties are immediately and very powerfully stimulated. Upon emerging from the bath, if the reaction takes place, the tiny arteries dilate and cause the skin to be flushed, the pulse and respiration soon become normal, and the bather experiences very quickly a sensation of warmth and general well-being. This reaction is the test of prime importance as to whether or not the bath is well borne. With practised bathers it will take place very speedily, and a delightful feeling of warmth will very soon be the reward of having for a moment braved the cold water. After leaving the bath, in order to aid the reaction the bather should rub the body from head to foot with a rough towel till the skin fairly glows, and when entirely dry the clothing may be put on without delay.

While most persons are able to take cold baths, they should become accustomed to them gradually. Not only will well persons maintain their health and strength, but many in poor health, and especially those of a nervous temperament, will derive much good from the daily cold bath. The best time to begin systematic cold bathing is in the warmer months, and by the time winter arrives they can be kept up with very little trouble or discomfort. If the bather has not the conveniences of a tub, or fears such a decided change as a tub bath, it is well to begin with a cold **sponge bath.** The sponge should be saturated with cold water and squeezed over the arms, then over the chest and back, and finally over the legs, after which a vigorous rubbing should be taken. The temperature of the water can be raised somewhat at first, and gradually lowered as the bather becomes more accustomed to the cold water. The temperature of the water should not be so extremely low, however, as to interfere with a thorough and speedy reaction. A very beneficial way of taking the morning cold bath is by means of **the shower,** which is stimulating through the impact of the water against the skin as well as through its temperature. Nothing quite equals the full tub bath, however, if the bather will begin with water only moderately cold, or will first become accustomed to the sponge bath, and then change to tub baths. One of the most benefical results of cold baths is the almost universal immunity to catching cold, as every one who takes a cold bath daily will declare.

The Warm Bath.—The cold and the warm baths are almost directly opposite in their physiologic action and purposes. The warm bath dilates the as it gives them too great a shock, or is too weakening, or is not followed by a proper reaction. On the contrary, however, most persons can take a cold bath every morning if they will only make up their minds to do so and go about it properly. It would not, of course, be advisable for one advanced in years, when the blood-vessels are naturally weak, to risk apoplexy by plunging into a cold bath without being properly trained to it by gradual stages.

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The Warm Bath.—The cold and the warm baths are almost directly opposite in their physiologic action and purposes. The warm bath dilates the tiny arteries, as is shown by redness of the skin, and causes profuse perspiration. The pulse and respiration are increased in frequency and the temperature is raised. The warm bath has an extremely soothing effect on the nervous system, and for this reason is best taken at night before retiring. The perspiration which is likely to continue after a warm bath is disagreeable to some, and may be prevented by sponging the body with cold water at the end of the bath. After an unusual amount of physical labor, when the muscles are sore and aching, nothing is more welcome or soothing than a warm bath. The blood is withdrawn from the muscles, lessening chemic change, and pain and soreness vanish speedily. In addition to removing muscular soreness and pain, the warm bath is relaxing and tends to relieve spasmodic conditions or cramps. For those who suffer from difficulty in getting to sleep, a warm bath just before retiring will often invite a refreshing slumber. While the warm bath is to be highly recommended as a means of relieving weariness after prolonged physical exertion, under no circumstances should a cold bath be taken at this time.

The hot bath (above 98° F.) should not be taken except upon the advice of a physician.

The tepid bath has no decided physiologic effect and is generally employed for cleansing purposes. It may be taken any time during the day, though preferably in the afternoon or just before bedtime.

The proper time to bathe is just before a meal or about three hours after. In order to digest food properly the stomach needs an abundant supply of blood to form its necessary juices and ferments, and if the blood is diverted from the stomach to the surface of the body by means of a bath the digestion will necessarily suffer.

Soap.—As water alone cannot dissolve the grease upon the skin, the use of soap is essential in order to effect a thorough cleansing. Soap is a combination of a fat with an alkali in greater or less excess. The latter combines with the fat of the skin, rendering it soluble and freely miscible with water. Potash is the alkali used to form soft soap, while a hard soap is produced by combining the fat with soda. A soap is said to be neutral when the alkali nearly balances or is in very slight excess of the fat, and in this class are included most of our ordinary toilet soaps. A good soap should be made of pure and fresh fat, should not contain too much alkali, which tends to irritate and roughen the skin, and the percentage of water should not be so high as to cause unnecessary waste. Adulteration with foreign substances, such as silica, which is added to increase the bulk, should be avoided.

The harm actually done by impure soaps is very small in proportion to the amount of fear and apprehension expressed concerning their use. No one stops to ask just what special make of bread is pure, but continues to eat whatever bread appears to be wholesome and palatable; and similarly any toilet soap upon the market may be used with impunity by the majority of people. A soap that will form a large amount of lather is not on that account valuable, for cocoanut oil is often added to produce this result. The expense of a soap is a better test of its value, as a good soap cannot be made very cheaply. The various soaps that are claimed to have soothing properties are not to be recommended on that account, as the most that is desired of a soap is that it shall be simply pure and non-irritating.

Medicated soaps are of little use, although great hopes were expressed as to their usefulness when first introduced. No special therapeutic value can reside in a substance like soap which is intended to come in contact with the skin for such a short space of time. Tar soap has attained a considerable popularity, especially for use in shampooing the head. For this purpose it is generally pleasant and effective, but with the exception of a strong odor it cannot be said to possess any very unusual quality.

Sea-bathing.—There are numerous causes that tend to make sea-bathing beneficial to the health, as well as a pleasure to the majority of people. The very fact that a bath in the ocean is enjoyable will increase its beneficial effect, and, indeed, any exercise or recreation will be of greater benefit if undertaken cheerfully and not considered as a tiresome matter of duty. The fine, pure air of the seashore constitutes one of the important advantages to be derived from sea-bathing. Breezes from the ocean are always fresh and free from micro-organisms, and constitute an invigorating tonic for healthy as well as for many sickly persons. The shock of the cold bath is always lessened by the exercise taken, especially if the bather can swim. The motion of the waves acts as a sort of massage to the body and adds invigoration to the bath.

It is rather doubtful whether any special virtue resides in the large amount of salt and greater density of sea water. It has been remarked that very little if any salt can be absorbed through the skin, and this alleged advantage of sea-bathing is probably mostly in the mind of the bather. Many persons abuse the privilege of bathing in the ocean by remaining in the water until their fingers and lips are blue and teeth are chattering. All are not alike in their ability to bear cold water, and convalescents or persons with serious organic disease should bathe only under medical supervision. No one should remain in the bath until thoroughly chilled. Ten to twenty minutes should constitute the range of duration.

No one should attempt to plunge into the water suddenly when overheated, and if there is any considerable perspiration it is well to sponge off the body with cold or cool water before beginning the bath. The morning is the most appropriate time to take the daily bath in the ocean, as its general purpose is to be invigorating, and it is also most conveniently taken when the water is at high tide. After bathing in the salt water many find it agreeable to take a brief shower or sponge bath of fresh water. When the bath-house is provided with an inner courtyard it is healthful and advisable for the bather to lounge about in the sun for a while and allow the air as well as sunlight to come in contact with the skin, and then to don the clothing leisurely.

The word "bath" does not always refer to an ablution with water, but in a broader sense means surrounding the body with any medium whose quality or temperature is unusual. Thus we speak of the hot-air bath, the hot-vapor bath, the compressed-air bath, etc.

The Turkish or hot-air bath serves several useful purposes, and is well borne by the average healthy person. Its systematic use may at times be advantageous, although it is for many an expensive luxury and not accessible outside of cities. In taking a Turkish bath, the bather, after removing his clothing, enters the warm room where the temperature is only a little above that of the body. Here he remains for a short time till a gentle perspiration appears upon the skin. He next enters the hot room, where the temperature ranges from 120° to 140° F., and sometimes a still hotter room is provided where the temperature may exceed 170° F. Upon entering the hot room the inexperienced bather often feels a sensation of nausea or suffocation; but, as a rule, in a well-ventilated bath these uncomfortable feelings will vanish with the appearance of a free perspiration. A practised bather will suffer no inconvenience in the hot room, and will perspire much more freely and much more quickly than the beginner. By drinking a glass of water before or during the bath the production of perspiration is greatly aided. After leaving the hot room the bather is shown to a moderately cool room and reclines while the attendant lathers him from head to foot and scrubs and massages him vigorously. This removes all the dried epithelial scales, and as a means of cleansing the skin it may be said that the Turkish bath is without an equal. The soap is removed by a douche, beginning with warm and ending with cold water. The bather may then take a plunge in a tank of cold water if this is afforded by the establishment, or immediately repair to a cool room and recline for a half hour or more wrapped in a blanket. For persons who are exhausted from great exertion and whose muscles and joints are sore and stiff the Turkish bath is most refreshing. Many sufferers from rheumatism will derive relief from a systematic course of such baths. The Turkish bath is often successfully resorted to for breaking up a cold.

The Russian bath differs from the Turkish bath in substituting hot vapor for the hot air of the latter. Perspiration cannot take place as readily in the Russian bath as has been explained, and for producing a copious perspiration the Russian bath is inferior to the Turkish. It is employed in some cases of chronic rheumatism, and is especially beneficial for dry forms of bronchitis.

Bath-pruritus.—A recent writer speaks of a disagreeable and annoying result occasionally produced by bathing, which he calls "bath-pruritus." He describes it as a sensation of burning, or more often itching, chiefly confined to the lower extremities, which appears very shortly after an ablution. Its duration varies from a few minutes to a half hour. It may follow bathing in salt or in fresh water. The itching seems to be aggravated by too long continuance or extremes of temperature of the bath; by the use of soap that is too strong or is allowed to remain upon the skin. Indulgence in scratching seems to increase the pruritus. The writer further states that the affection is likely to occur in persons with a naturally irritable skin and a tendency to urticaria or hives. This statement suggests sufficient cause for the majority of cases of this so-called bath-pruritus. Indeed most persons who suffer from itching after a bath must look for the cause in a natural irritability of the skin rather than in the bath itself.

The treatment, which is not always satisfactory, is based upon general principles. Any digestive or nervous disturbances are to be corrected, and a restricted diet and plenty of exercise are to be advised. The intestinal action should be rendered free by laxative food or medicine. The bath should not be of too long duration, and for cleansing the skin a good toilet soap should be employed. After the bath it is well to dry the skin gently without friction, and then to apply freely some dusting-powder, such as equal parts of starch and zinc oxid.

Care of the Complexion.—From the exposure to which the face is naturally subjected it should receive no less than two daily ablutions. Cold water should be used for washing the face, as it has a stimulant action on the blood-vessels and improves the circulation in the skin. It also improves the tone of the elastic fibers of the skin and tends to delay the appearance of wrinkles. Furthermore, the general sensation of bathing the face with cold water is most refreshing. If the water is so cold as to be disagreeable, its temperature may be raised slightly ; but it is not advisable to use hot or warm water regularly for washing the face. Using hot water upon the face and then undergoing exposure to cold air or wind, especially in winter, has a decided tendency to produce chapping and roughening of the skin.

It is a question as to whether the **use of soap** is advisable for the daily cleansing of the face. For the perfectly healthy skin soap is not absolutely essential, and its too frequent use may prove injurious. For persons, however, with a very oily skin, or for those residing in cities where the air is laden with soot from the use of soft coal, the daily use of soap may be necessary. If the complexion is sallow and there is a tendency to pimples and blotches, nothing will serve better to stimulate the circulation and to improve the complexion than vigorous pinching of the face by the fingers.

Questions are frequently asked regarding the advisability of using various toilet creams and lotions on the face, and about the use of the various complexion or face powders. If the skin is unnaturally dry, there can be no harm in the application of a little grease to the face, while the employment of powder is largely a matter of taste. In hot weather the application of a small quantity of rice powder to the face will often be grateful, and can do no harm to the complexion.

The preparations known as **cold creams** are mixtures of some solid fat as wax or spermaceti, with an oil such as castor or almond oil, to which some fragrant substances are added. They can be used on the face with perfect freedom and without danger of injury. The **toilet or face creams** are mucilaginous preparations containing tragacanth and other ingredients, and are pleasant applications for a fissured or chapped skin.

Toilet lotions serve a similar purpose, and are generally transparent preparations containing glycerin and other substances.

For removing summer freckles and tan the following lotion may be employed :

℞.—Sulphocarbolate of soda,	50 grains ;
Glycerin,	2 ounces ;
Rose-water,	1 ounce ;
Alcohol,	1 ounce.

For an obstinate case of freckles the following may be recommended :

℞.—Bichlorid of mercury,	6 grains ;
Alcohol,	1 ounce ;
Glycerin,	2 ounces ;
Oil of lavender,	10 drops.

Face powders are generally composed of one or more of the following substances : Talcum, starch, bismuth, chalk, zinc oxid, and magnesia, and, as a rule, are entirely harmless. Lead has at times been employed as an ingredient of face powders, and if the powder contains this substance it is objectionable from the possibility of a poisonous effect.

CLOTHING.

The materials most frequently used for clothing are derived partly from the animal and partly from the vegetable kingdom. From the former are obtained silk, wool, furs, and leather, while from the latter are derived cotton, linen, and rubber. In discussing the value of these different substances as materials for clothing, two important physical properties to be considered are their power of conducting heat and capacity for absorbing moisture.

The heat-conducting power which a garment possesses does not depend to any great extent on the fabric itself, but chiefly on the manner in which that fabric is woven. Dry air is a very poor conductor of heat, and any garment which is loosely woven and is capable of holding considerable air in its meshes will be a poor conductor, and will consequently feel warm. Wool, for the reason that it is naturally woven into cloth that is loose in texture and porous, is a most valuable clothing material for use in cold weather. If numerous thicknesses of woollen clothing will not suffice to withstand severe cold, then furs may be supplemented. Cotton is naturally woven into cloth whose texture is compact and not porous, and is, therefore, not so valuable as wool for use in cold weather. When, however, specially manufactured so that its texture closely resembles that of woollen cloth, it may be a fair substitute for wool.

The capacity for absorbing moisture is possessed by wool to a very high degree, silk being next to wool in this respect. Linen is only moderately, and cotton very slightly, hygroscopic. A woollen garment has the property of absorbing a great deal of moisture without feeling wet. Evaporation of moisture proceeds slowly from woollen clothing, while cotton clothing, especially underwear, speedily becomes saturated with moisture and evaporation is liable to take place suddenly, with resulting chilling of the body. In speaking of flannel, some philosopher has made the paradoxical remark that no matter how cold and wet it may be it is always warm and dry. As flannel underclothing is so hygroscopic and does not allow the moisture it absorbs to evaporate too rapidly, it is the most valuable material for underclothing for use in temperate and changeable climates. For cold weather, heavy woollen underwear cannot be surpassed for warmth and comfort. By manufacturing cotton into cloth with large meshes or air-containing spaces a very fair substitute for flannel underwear has been obtained. While probably not superior to flannel for underclothing, this material is valuable for persons who find wool next to the skin uncomfortable. Many, however, who think at first that they cannot bear wool next to the skin will, after awhile, tolerate its presence. Another substitute for woollen underwear is found in merino, which consists of a mixture of wool and other materials.

Woollen underclothing has the disadvantages of shrinking readily when washed and of absorbing odors readily. The former fault can be somewhat overcome, however, by buying goods which have been shrunken and by having them washed in tepid water, with little soap and no violent friction. On account of this tendency to shrink, old flannel underclothing is not the equal of new, for after repeated washing the fabric becomes "felted," less porous and of a closer texture, and consequently not so warm.

Clothing for Cold Weather.—It is a mistake to try to endure cold weather without wearing sufficiently warm clothing. Whenever a feeling of cold or chilliness is experienced it is highly proper to put on an extra garment without delay, and it is folly to wait till the body is chilled before taking the trouble to make a change of clothing. The habit of wearing thin clothing all the year round and of going without an overcoat through the winter to display a vigorous constitution is not advisable. It is true that some persons seem to keep well from such a course, and while the heat-producing power may be equal to the extra demand, it is at the expense of the nervous energy of the individual. Children and old people, whose power of producing heat is limited, should be proportionately warmly clad, and the practice of dressing children with the legs exposed is as cruel as it is unhygienic.

Clothing for Warm Weather.—For use in tropical climates flannel- underwear is found to be too warm, and cotton, silk, and linen are more serviceable materials. The Chinese plan of wearing a net next to the skin, and over it a thin silken garment, is admirable, the silk readily absorbing the perspiration, while the net prevents the silken garment adhering to the skin. Silk underclothing is always agreeably soft and fresh, but it is expensive and is likely to shrink considerably in washing. Much of the underclothing said to be pure silk is probably of mixed composition. Thin linen for tropical wear is said to be very acceptable and always has a feeling of freshness, but it is more expensive than cotton, which is for practical purposes the most available material to be employed. Cotton cloth is strong, durable, cheap, does not shrink readily, and absorbs odors very slightly.

As a protection against excessive heat **the color of clothing** is of considerable importance. By placing pieces of cloth of light and dark shades upon snow it is found that the snow melts more readily under the dark than under the light cloth. From this we infer that light colors, such as yellow or white, which absorb fewest of the heat rays of the sun, are the more suitable colors for tropical clothing. The presence of cheap **aniline dyes** in underclothing and stockings will occasionally cause considerable irritation to the skin, though much less frequently than is generally supposed. By observing cleanliness and discarding the offending garment relief will very promptly be afforded.

Underclothing should be washed frequently, depending on the amount of perspiration of the wearer. It should be aired very thoroughly over night, and the same set should never be worn both day and night. Damp underclothes offer a most excellent soil for the growth of micro-organisms, and favor the development of certain parasitic skin-diseases which flourish only under conditions of warmth and moisture.

Rubber or mackintosh clothing is very useful as a protection against wind as well as rain, and is suitable for persons whose occupation requires considerable exposure but not much exercise, as, for instance, coachmen or seamen. For active occupations it is to be condemned. Being impermeable to air, the perspiration cannot evaporate as readily as it does when woollen garments are worn. There has lately been introduced a form of waterproof cloth that differs from rubber in being entirely permeable to air. Overcoats made of this material will shed rain perfectly, and, unlike a mackintosh, will feel perfectly comfortable when exercise is taken. As this material allows free evaporation of the perspiration it forms the ideal waterproof garment.

Shoes.—There is hardly an article of clothing upon which our comfort depends to so large an extent as upon the covering of the feet. It seems superfluous to say that shoes should fit the feet perfectly, yet owing to the demands of fashion this does not always seem to be the chief consideration in purchasing shoes. If expense need not be considered, boots or shoes should be made to order. By standing in the stockings a tracing is made about the foot and from this the proper last is constructed. In a well-made pair of

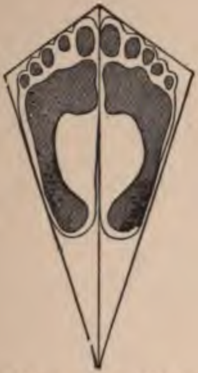

FIG. 14.—Normal feet (Whitman).

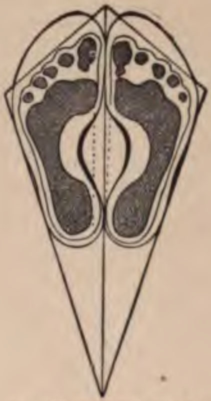

FIG. 15.—Proper soles for normal feet (Whitman).

shoes the inner sides should be nearly parallel and not diverge greatly when the wearer stands with feet together.

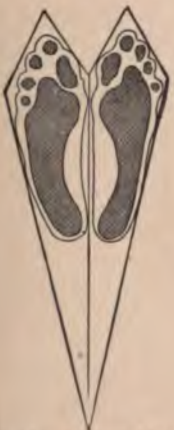

FIG. 16.—Deformed feet (Whitman).

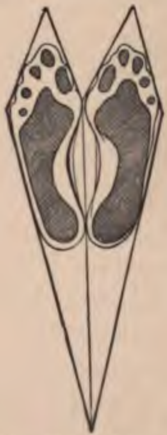

FIG. 17.—Shoemakers' soles (Whitman).

The outer side of the shoe should have a gentle curve inward, and the toe should in no case be pointed. In Fig. 14 is shown an impression made by the normal foot. To provide a sensible form of shoe for a foot of this shape it does not seem rational to have the toe narrow and pointed; nor, on the other hand, perfectly square as is seen in some of the so-called common-sense shoes. The sole of a properly constructed shoe should have the shape shown in Fig. 15. In Fig. 16 is given an illustration of a foot that has become deformed and made to fit a shoe whose shape is improper and unhygienic (Fig. 17).

It is most essential to comfort that a shoe should be sufficiently long. A good rule to follow is to wear shoes that are at least three-quarters of an inch longer than the foot. By observing these common-sense ideas many troublesome conditions, such as corns, bunions, and others more serious, may be prevented.

The soles of the shoe should be of the extension type if intended for hard walking, as the projecting part affords considerable protection against loose stones. If the sole is flat, a much better support is given the foot than in the usual sole that turns up from the ground (see Figs. 18 and 19). The leather should be moderately thick for protection, and at the same time pliable.

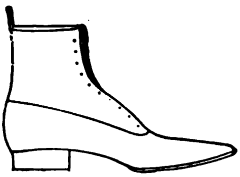

FIG. 18.—The rocker sole (Whitman).

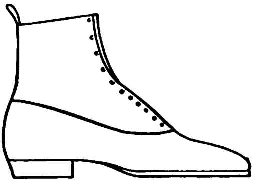

FIG. 19.—The flat sole (Whitman).

The heels should always be broad and low. The high heels so frequently worn by women for the purpose of increasing their height and lessening the apparent size of the foot are harmful. They tend to produce weakness of the arch of the foot through atrophy of the plantar ligaments. Low shoes are a hygienic form of footwear, since they allow excellent ventilation of the foot, and are especially desirable for use during the warmer months.

Patent leather shoes are not advisable for continued wear, since, being impermeable to air, they do not allow proper evaporation of the perspiration from the feet. However uncomfortable rubber shoes may feel, they are probably the means of preventing many colds; they should never be worn unnecessarily. For those who have to do considerable walking in wet weather and cannot conveniently wear rubbers, hobnails are a great protection to the soles of the shoes, and also add to the firmness of the step.

Socks and stockings should often be changed, the frequency depending on the amount of perspiration of the wearer's foot. In the case of those who suffer from excessive perspiration of the feet, at times of a bad odor, the socks or stockings should be changed daily. The feet should be washed and dried without friction, and over the feet and in the fresh socks may be dusted the following powder—salicylic acid, 1 part; starch, 4 parts.

Garters.—Unfortunately, ill-fitting shoes are not the only portions of the human attire that bring about evil consequences and are to be condemned. Any article of clothing which unnaturally constricts a portion of the body is harmful and unhygienic. The circular elastic garter acts as a constant tourniquet about the leg and interferes with the circulation of blood in the veins. These will tend to dilate after awhile and become tortuous, giving rise to the condition known as **varicose veins.** The dilated veins generally prove to be sources of considerable annoyance, and at times of danger. Instead of using circular garters, the proper plan is to suspend the stockings from some part of the underclothing.

Corsets.—The subject of improper clothing could not well be passed by without adding a few words to the volume of protest already entered against the wearing of tight corsets. The practice of compressing the body unnaturally by means of various kinds of stays seems to continue in spite of the hostility of practically all physicians. Constricting the waist too tightly causes a change in position and interferes with the functions of many of the internal organs (see page 44). It prevents the proper muscular development of women, as no tightly-laced woman can indulge in any vigorous exercise. Corsets greatly interfere with the fullest attainment of health and vigor. When tightly laced they lessen the amount of air that can be taken into the lungs. As a result the blood is imperfectly äerated, deteriorates in quality, and the wearer suffers from anemia.

The entire list of injuries attributed to wearing tight corsets is a formidable one, and should cause every woman to think before continuing the practice. Most women say that they would have a feeling of utter collapse if the stays were to be laid aside. This is due to the imperfect development of muscles that are not called into play when stays are worn, but which should be strengthened by exercise in order to perform their natural functions.

A certain writer has expressed opinions about stays that have given great consolation to women who wear them. She says that women breathe naturally with the chest, especially the upper portion, and employ abdominal breathing very slightly, so that tight lacing which does not interfere with chest breathing is hygienic and proper. Opposed to this view, some experimenter has found that Indian girls who have never constricted the waist by stays breathe with the diaphragm as naturally as do men, and conclude that the insufficient method of breathing with the chest, common in women, is itself due to the habit of wearing stays. As a matter of fact, no skilled singing teacher would ever consent to allow his pupils to sing when handicapped by a tightly-laced waist, but would insist upon their breathing to their utmost capacity. This can only be accomplished when both chest and abdomen are free and unhampered.

Bed-clothing should not be unnecessarily heavy. A light covering, such as an eiderdown quilt, will afford more warmth than a blanket of greater weight, owing to its capacity for retaining more air in its meshes. Similarly two coverings will be warmer than one which is equal to both in thickness, on account of the layer of air contained between them. Bed-clothing should be aired thoroughly every morning, the windows of the sleeping-room being opened for this purpose.

CARE OF THE HAIR.

A fine head of hair is a possession universally prized, and one which is frequently neglected by its owner as often through ignorance as through carelessness. In the preservation of the hair some persons have a great natural advantage over others. If there is an inherited **tendency to baldness,** as shown by a thin and poorly nourished scalp, there will be greater difficulty in preserving the hair than otherwise.

The scalp is comparable to the soil. Neither hair nor plants will grow luxuriantly if the quality is poor. A scalp which is favorable to the growth of hair is thick and pliable, and moves freely over the bones of the skull beneath. If the scalp is very thin, the blood-vessels contained will be few in number. If it is drawn tightly over the skull, it will tend to constrict the blood-vessels, lessen the supply of blood to the scalp, and cause atrophy of the roots of the hair from pressure. The two principal causes which bring about a premature thinning of the hair are a deficient circulation of the blood in the scalp and the constant presence of dandruff.

Dandruff is a collection of epithelial scales mixed with dried sebaceous matter, and is the forerunner of premature baldness in a large percentage of cases. It will be present to a greater or less degree in many scalps unless it is constantly guarded against. It is highly important to keep the scalp perfectly clean and free from dandruff, and to attain this end daily brushing of the hair and frequent shampooing are necessary.

Hair-brushes.—The hair should be brushed morning and night for several minutes until there is a feeling of warmth in the scalp and all particles of dandruff are removed. For an adult the brush should be a stiff one, with the little tufts of bristles widely separated to facilitate cleaning. For children and for those with very sensitive scalps, softer brushes must be used. Brushes should never be so stiff nor the brushing so vigorous as to produce any soreness of the scalp. Brushes should be frequently washed in water containing a little ammonia, and then dried in the sun with the bristles down.

Combs are chiefly useful for disentangling snarls and dressing the hair, and may be employed daily with the brush. The teeth of the comb should be wide apart, have blunt ends, and be free from any irregularities which might tear the hair. In no case should the old-fashioned fine-toothed comb be used, as this pulls out the strong hairs, especially if the growth is luxuriant, and the fine points may produce disease of the scalp from irritation.

Many persons are morbidly afraid that any considerable amount of **brushing and combing** will cause a serious loss of hair.. Its effect, however, is just the opposite and increases the growth of hair by stimulating the circulation in the scalp and by removing dandruff. Brushing removes many loose hairs which are ready to fall, but their place will soon be taken by new and more vigorous ones. The groom knows by experience that the only way to keep the coat of his horse thick and glossy and in a healthy condition is to constantly use the currycomb and brush, and that he is not likely to use either too much.

Shampooing.—Many persons who are favored by nature with a luxuriant growth of hair and who perhaps consider themselves immune to baldness, will grudgingly give any time to the care of the hair and consider shampooing especially distasteful. To keep the hair clean and free from dandruff, shampooing at intervals is very necessary.

There are many popular fallacies concerning questions of physiology and hygiene, and some ideas about shampooing of the scalp are no exception to the rule. Shampooing, like brushing, also removes some loose hairs, but by cleansing and stimulating the scalp it forms a most important means of preserving a good head of hair or aiding to restore it after a temporary falling. The **frequency** of shampooing of the scalp depends on the rapidity with which dandruff accumulates, and to some extent on occupation of the individual. For some persons, washing the scalp once a month will be found sufficient to keep it in a hygienic condition. Others, and especially those whose business requires much travelling or exposure to dust and dirt, may find it necessary to wash the head once a fortnight, or even once a week. There is never any danger of shampooing the healthy scalp too frequently, notwithstanding the opposite statement so frequently made by some hairdressers, whose chief stock in trade is some "tonic" of alleged miraculous virtue. When the hair has begun to fall out prematurely, due to long neglect or following an illness, it is well to begin shampooing the head twice or even three times a week, and to gradually lessen the intervals to once in three or four weeks.

Not only are some afraid that the shampoo will cause considerable loss of hair through the friction employed, but they fear that all the oil in the scalp will be removed and great damage done to the hair by the dryness resulting. Immediately after washing the scalp, especially if alcohol be used in addition to the soap, the scalp will certainly feel dry, but it will soon become more oily than usual due to improvement in circulation and consequent stimulation of the oil-glands. This will be the result in the majority of cases, and very few persons will suffer from dryness of the scalp if they practice shampooing with sufficient frequency. Some persons actually say that after the shampoo the scalp becomes too oily. When the scalp fails to respond to the mechanical stimulus of shampooing by producing an insufficient amount of sebaceous matter, then it is well to rub into the scalp some form of grease or oil. Nothing answers the purpose better than pure vaseline, although some barbers prefer to use olive oil. This can be conveniently applied by a medicine-dropper, after making numerous parts in the hair. The use of soap on the hair agitates many persons who, though employing the best soap in cleaning the skin, consider that shampooing is a dangerous procedure unless the soap used is recommended by physicians. Any good toilet soap upon the market will answer the purpose, and more harm is done by refraining from the use of the shampoo than by using an inferior quality of soap on the hair.

The addition of alcohol to **shampooing liquids,** as in the tincture of green soap will greatly assist the thorough cleansing of the scalp. The addition of an egg to the shampoo is thought by many to make it more pleasant and effective. As the egg has no cleansing effect its use is largely a matter of taste. There is no more reason for its employment upon the scalp than for its use in the daily washing of the hands and face.

A very satisfactory shampoo liquid is found in the linamentum saponis mollis of the Pharmacopeia, which consists of 50 parts of soft soap, 2 parts of oil of lavender, and 33 parts of alcohol.

In the operation of shampooing any ordinary good toilet soap may be selected. A lather is then formed and rubbed vigorously into the scalp with the finger tips or a stiff brush, a nail brush being very convenient for the purpose. The lather is best removed by a warm-water douche, always ending the process with cold water to lessen the danger of contracting a cold. The hair is then to be dried as thoroughly as possible with towels, and to complete the drying it is well to remain for a while in the sun or near an open fire or radiator.

Head-gear.—While many persons naturally possess a thin head of hair and a poor circulation, they are handicapped still further by various causes that tend to lesson the circulation in the scalp. One of these causes is the wearing of hats. The hats worn by men at the present time, especially the Derby and silk hat, allow very little ventilation, prevent the access of sunlight as well as air, and do not permit the proper evaporation of the perspiration. The tight-fitting brim also constricts the blood-vessels and hinders the circulation. Women's hats have no tight brim, allow free ventilation, and, unless very heavy, are seldom objectionable in this respect. The interesting and oft-repeated arguments against the wearing of hats may here be cited. Savages who go bareheaded do not suffer from baldness, and the same immunity to early falling of the hair is said to be the good fortune of the lads of the "Blue-Coat School" in London. These boys never wear any hats, however stormy the weather may be nor how low the thermometer may descend.

As the hats of the present day seem to be necessary evils, the only practical advice that may be given is that they should not be worn unnecessarily, especially when the head is perspiring, and that they should not be jammed on the head with such firmness as to interfere with the circulation of the scalp. The fact that women are more free from baldness than men may be due in a slight degree to their wearing a more hygienic form of head-gear, but undoubtedly the chief cause lies in their possession of a thick scalp and an underlying cushion of fat, which is naturally better adapted to support a good growth of hair.

Some physicians think that the **amount of brain-work** done may be a factor in bringing on premature baldness, but this has not been definitely proven.

The answer to the question as to what can be done to improve the circulation of the scalp and the growth of the hair is, briefly—mechanical stimulation. This may be practised through shampooing, massage, and the local application of electricity. Shampooing has been considered, and its thorough and frequent practice cannot be too strongly urged.

Massage of the Scalp.—Vigorous daily massage, if continued for a considerable time, will tend to improve the circulation and to increase the growth of hair. If the scalp is pale and thin, it is well to combine a few minutes of massage by the finger-tips with the daily morning and night brushing. A variety of motions may be practised, such as moving the fingers over all parts of scalp, and then placing them firmly on the scalp and moving the scalp itself over the bones beneath.

Electricity acts merely as a local stimulant to the circulation, and is best used in the form of galvanism. A wire-brush electrode is attached to the negative pole of the galvanic battery, and applied to the scalp through the hair until the former becomes well reddened.

Cutting the Hair.—Many persons entertain the false idea that cutting the hair increases its thickness. While it may aid to some extent the rapidity of growth, cutting certainly does not increase the number of hairs. To keep the hair short in children up to the age of eight or nine years is generally deemed sensible and hygienic. Its good effect is mostly due to the easier access of air and sunlight to the scalp and to the greater ease with which the head can be kept clean, although some think that if the hair of a growing child is kept short there will be less of a tax upon its strength and vitality.

The opinion seems to be pretty general that **shaving** with a sharp razor will produce a thicker and firmer growth of hair, although one recent writer on hygiene claims that shaving actually has a depilatory effect. In the process of shaving, the roots of the hairs are stimulated to a slight degree, and a coarser and thicker growth upon the face of a young man doubtless results in due time; but time rather than shaving is responsible for the change. The experiment occasionally tried by enthusiasts of shaving the head in the hope of obtaining a better growth of hair is never productive of any brilliant result, and may be considered as absurd and useless.

In **dressing the hair** it is important to make no violent traction upon the roots, as this has a tendency to loosen and cause a falling of the hair. There should be no twists or knots which produce feelings of discomfort for such are certain to prove injurious. There is no great objection to **curling the hair** if it is not done with too much vigor. Curl papers, if not put on so tightly as to pull on the roots of the hair, are not likely to do harm. Curling irons, however, are often overheated and make the hair unnaturally dry and brittle.

A very absurd idea that pervades the mind of the average "tonsorial artist" is that **singeing the hair** will tend to preserve it and to stimulate its growth. There is no truth in the barber's assertion that the hair is a hollow tube which will allow the escape of oil, and that if the ends can only be sealed by singeing much benefit will result.

Hair restorers or hair tonics are fully as useless as singeing. These preparations, which are widely advertised, fail utterly to accomplish the purpose for which they are employed. Shampooing, brushing, massage of the scalp, and attention to the general health, and not the use of a hair tonic, are the only means of preserving a good head of hair and aiding its restoration after falling.

Pomades are mentioned only to say that their use in general is considered unnecessary, while to most people they seem uncleanly and disagreeable. A generation ago some oily dressing for the hair was universally used, largely because it was the fashion. Bear's grease was often used as an ingredient of the pomade, in hopes that some hair-restoring properties might be possessed by the fat of an animal as naturally hairy as the bear.

Many young men indulge in the habit of **frequently wetting the hair** in order to make it set smoothly. In addition to producing a doubtful esthetic effect, this practice is harmful by tending to cause decomposition of the roots of the hair. As has been stated, there is no harm in washing the hair frequently if it is subsequently dried with towels.

Removal of Superfluous Hair.—The use of depilatory pastes or substances to remove superfluous hairs is not recommended, except upon the advice of a physician. These pastes will often remove a downy growth of hair, but cannot remove large stiff hairs without doing too much damage to the skin to warrant their employment. For removing large hairs, the only satisfactory method is the slow but sure one by **electrolysis.** By this method an experienced operator can remove any number of large hairs permanently without leaving any scars or causing much pain.

Gray Hair.—An eminent dermatologist has remarked that the only sensible thing to do for gray hair is to admire it. While gray hair undoubtedly improves the looks of some people and is welcomed by them, it is to others a source of considerable annoyance. In the rare cases of sudden blanching of the hair, such as sometimes follows profound mental disturbance, a return of the former color is a possibility, but even this could not probably be aided by any efforts of the physician. Nothing can really be done to prevent the hair turning gray.

Dyeing the hair is an exhibition of poor taste, and is really only excusable in the case of young persons whose hair has turned gray at an unusually early age. Many of the dyes for coloring the hair black contain lead, and on this account should be avoided, as cases of lead-poisoning from the use of hair-dyes undoubtedly have occurred.

Before the application of any hair-dye the head should be thoroughly shampooed and then dried. The dye is most conveniently applied to the hair by a tooth-brush, avoiding contact as far as possible with the scalp.

Leonard recommends the following harmless hair-dye for producing a **black** color.

℞.—Bismuth citrate,	1 ounce ;
Rose water,	2 ounces ;
Distilled water,	2 ounces ;
Alcohol,	½ ounce ;
Ammonia water,	a few drops.

To be applied in the morning.

℞.—Sodium hyposulphite,	1½ ounces ;
Distilled water,	4 ounces.

To be applied at night.

To obtain a **brown** color a mixture of pyrogallic acid and rose water may be used

Care of the Beard.—An equal amount of care should be bestowed upon the cleanliness of the beard and mustache, as is shown in the case of the scalp.

The frequent ablutions of the face during the day should include both beard and mustache. To give softness and lustre to the mustache, preparations known as brilliantines may be employed without danger of a harmful effect. A suitable formula for such a preparation consists of glycerin, castor oil, and alcohol in the proportions of one, two, and three respectively, to which a proper amount of perfume may be added.

In regard to **shaving,** it may be said that it is always a good plan for a man to practise shaving himself and so avoid any possible danger of infection from the barber-shop. In these establishments a number of diseases may be contracted, notably ringworm. This affection, so obstinate when attacking the hairy portions of the body, is usually acquired from the use of a damp towel, less often from the shaving-brush, the "clipper," or the hands of the barber. The razor is not at all likely to be the cause of infection. The damp towel offers a most excellent medium for the growth of the ringworm parasite, as this fungus, like ordinary mould, requires moisture for its development. If a barber-shop is to be patronized regularly, the customer should have a private cup, shaving-brush, and razor. If, in addition, the towels to be used are perfectly clean and dry, and the barber washes his hands thoroughly after shaving each customer, there will be still less danger of contracting ringworm and other infectious diseases.

Care of the Nails.—The proper care of the nails depends upon the observance of a very few and simple rules. The portion of skin overhanging the root of the nail tends to encroach too far over the lunula, and is likely to become torn and ragged, giving rise to so-called "**hangnails.**" These offer little openings through which infectious matter may enter and do a good deal of damage, and it is possible for blood-poisoning to result from infection through one of these apparently insignificant lacerations. The epidermis overhanging the root of the nail should be pressed back once or twice a week with some convenient instrument. For cleaning the nails, nothing but soap, warm water, and the nail-brush should be employed. The penknife should not be used in place of the nail-cleaner, as it scratches the under surface of the nail and makes a place for the lodgement of dirt. The surface of the nail should never be scraped.

A word of advice may be given in regard to **cutting the nails,** for it seems that the proper method is not universally known. The finger-nails are most conveniently cut in a curved direction, or they may be filed if this slower method is preferred. A pair of curved scissors is very convenient for cutting the finger-nails, but should not be used for the toe-nails, as these are always to be cut straight across. If, in addition to the proper selection of shoes, this last precaution is observed, a great deal of trouble and discomfort may be avoided.

For **removing stains from the nails** a solution of acetic acid and rose water, one part of the former to sixteen parts of the latter, may be employed. Oxalic acid is perhaps more efficient for accomplishing this purpose, but its use is not desirable, owing to its poisonous qualities.

HYGIENE OF THE VOCAL AND RESPIRATORY APPARATUS.

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THE NOSE.

THE nose is described as consisting of an outer, or facial, and an inner portion ; the latter lying within the skull.

The outer nose has a bony framework in its upper portion, consisting of the nasal bones and nasal processes of the upper jaw. The lower half of the outer nose is made of flexible cartilages, supported in the center by the septum, or dividing wall of the nostrils (Figs. 20, 21). The external nose has muscles of great importance in facial expression, and capable of dilating the nostrils during inspiration.

The inner nose consists of two lofty air-passages, extending back into the skull as far as the posterior end of the hard palate, or roof of the mouth. Here the nostrils end in a roomy chamber called the nasopharynx.

The inner wall of each nasal passage, or naris, as it is called, is formed by the division of the nostrils, or **septum** (Fig. 21). This is composed in its back and upper parts of two bones, the vomer, or ploughshare, below, and a thin plate of bone above, called

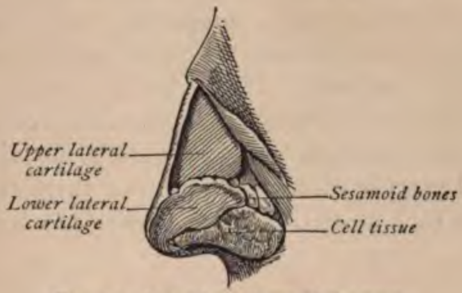

FIG. 20.—Lateral cartilages of the nose.

the perpendicular plate of the ethmoid bone. These two bones join behind to form a solid wall, but spread-

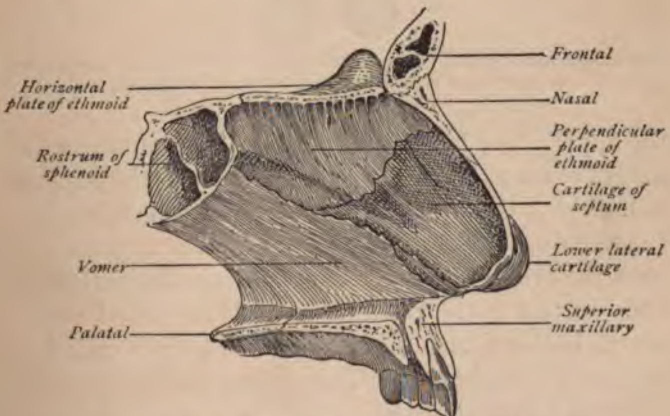

FIG. 21.—Cartilage and bones of the septum of the nose.

ing in front include, like a V, the front or cartilaginous part of the septum, which fortunately is very flexible; because if it were of bone, fractures of this part of the nose would occur very frequently.

The outer wall of the nose is made of a complicated bony framework, supporting three ledges or shell-like projections into the nasal cavities, called the **turbinated bodies.** These bodies consist of thin bone covered with mucous membrane, containing a sponge-like network of blood-vessels, forming what is called erectile tissue. There are three turbinated bodies in each nostril, called the lower, the middle, and the upper. The lower and the middle extend the whole length of the nasal cavity; the upper along the posterior half only. Underneath the lower turbinate we have the opening of the tube, or duct, conducting the tears from the eye to the nose; under the middle turbinated body we have the opening to a thin-walled cavity, which hollows out the upper jaw, and is called the antrum of Highmore. This cavity lies immediately external to the nostril.

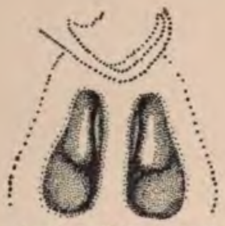

FIG. 22.—Anterior nares, showing white deposit of inspired magnesium-powder upon the septum and middle turbinals only.

Accessory Sinuses.—There are other bony cavities connecting with the nose in this location, two in the forehead, or frontal bone, and a large number of cells in a very thin bone at the top of the nose, called the ethmoid bone. These chambers in the bones of the skull all contain air.

The roof of the nose is formed by the nasal bones in front; behind this by a plate of thin bone separating the nasal cavity from the brain. This plate of bone contains many sieve-like holes, which give passage to the filaments of the nerve of smell, and is called the cribiform plate of the ethmoid bone. A hollow bone back of this completes the roof of the nose; it is called the body of the sphenoid bone.

The floor of the nasal cavity is formed by the hard palate, a thick, massive plate of bone forming also the roof of the mouth.

The mucous membrane of the nose is very sensitive, having many nerves of sensation from the fifth pair of nerves besides the special nerves of smell, which are found only along the space between middle turbinated body and the septum, in the so-called olfactory region.

A single layer of minute, microscopic epithelial cells covers the surface of the nasal mucous membrane, like pavement blocks, each cell having hair-like processes on its free surface, called ciliæ. Numerous little tubes, called mucous glands, keep the mucous membrane lubricated with mucus.

The best known of the functions of the nose is the sense of smell; but the other functions are more important to the health of the individual. The many folds and narrow passages of the nasal surface warm the air as it passes over them, at the same time supplying it with moisture to the extent of two-thirds saturation. The moist mucous membrane of the nose also catches almost all of the dust that escapes the many hairs, or vibrissæ, as they are called, which are placed at the entrance to the nostrils. Whatever dust lodges on the mucous surface is pushed toward the outer orifice by the minute ciliæ, which are in constant outward motion. With the dust, of course, any microbes entering the nose are also expelled. In addition to this mechanic expulsion, however, the nose probably possesses the power of destroying the bacteria by means of its mucus, which is germicidal, so that only a very short distance within the nostrils the mucous membrane is found comparatively free from microbes.

Obstruction in the Nasal Passages.—To keep the nose and the air-passages below it in a healthy state the nostrils must be open for the passage of air. The commonest cause of stopping up of the nose in children is enlargement by **adenoid growth** of a structure called the **pharyngeal or Luschka's tonsil**, or the third tonsil. This is placed behind the posterior openings of the nose, and when enlarged enough, may entirely obstruct breathing through it. Practically all mouth-breathing children have this form of obstruction, the external nasal passages being open. If this form of nasal blocking is allowed to persist, it has a very deleterious effect on the development of the inner nose, which from lack of use is retarded in its growth. In such cases the nasal passages at the beginning of adult life are as small as those of a child, while the upper jaw is narrow, producing an ugly protrusion of the front teeth and a characteristic stupid expression.

In adults, nasal obstructions are often due to **deformities of the septum**, which is either much bent to one side or thickened in such a way as to close up one nostril permanently. Other frequent causes of stoppages of the nose of a lasting character are mucous growths called **polyps.** The most common source of nasal occlusion in grown persons is swelling of the nasal mucous membrane.

Mouth-breathing, with its attendant evils, is the result of these obstructions to the free passage of air through the nose. Mouth-breathing allows the entrance of dust and microbes directly to the lower air-passages, larynx, trachea, and lungs; whereas in breathing through the nose most of these particles are lodged on the nasal mucous membrane and returned to the outer world in the ways mentioned. The bronchi and trachea have ciliated epithelium as well as the nose, and although this epithelium, by means of its waving, hair-like processes, is capable of expelling many of the minute foreign bodies that enter the lungs, still some reach the air-cells even under ordinary conditions when breathing is carried on with the mouth closed, while mouth-breathing adds enormously to their number. In this way the microbes of tuberculosis, pneumonia, bronchitis, influenza, etc. penetrate the lungs more readily than in nose-breathing. This is especially true of the rapid and forced breathing accompanying violent exertion. Through the open mouth diphtheria germs reach the larynx or tonsils directly.

Closure of one nostril, common in adults, compels the sufferer to try heroically to breathe through the other nostril, with consequent rarefaction of the air in the free nasal passage and the pharynx, thus by suction overfilling the blood-vessels and predisposing to catarrhal diseases. In singers the effect of nasal stoppage is to place undue strain on the voice by trying to overcome the lack of resonance due to the obstructed nose.

It is well known to long-distance runners that the breath gives out very soon if mouth-breathing is used, while breathing through the nose is soon followed by what is called "**second wind,**" during which respiration becomes easy again. Second wind is partly due to a dilatation of the blood-vessels, making the blood-pressure lower and the heart's action easier. It is also in part due to the fact that in breathing through the comparatively narrow nasal orifice the air enters the thorax with more difficulty than through the mouth; this increases the negative pressure within the chest, causes the respirations to be long and deep, and so gives the thorax an opportunity to pump blood as well as air into its cavity, thus aiding the heart in its work. So deep breathing through the nose during exertion tends to lessen the heart-strain of cycling, running, boxing, or other sports and exercises.

The foregoing statements sufficiently prove how indispensable to healthy respiratory organs is an unobstructed nose.

Causes of Nasal Disease.—A healthy nose needs no care by means of sprays, nasal douches, and the like. In fact, the care of the nasal passages involves chiefly a knowledge of the causes predisposing to nasal disease, and as far as possible the avoidance of these causes. There are, however, classes of nasal affections, such as malignant growths, bony tumors, etc., which are not preventable, but much can be done to limit the occurrence of the ordinary catarrhal affections of the nose which lead up to other morbid conditions, such as polypi or suppuration of the air-chambers about the nose called the sinuses.

First among the causes of catarrhal nasal affections is **exposure to cold,** especially of those portions of the body ordinarily protected by clothing. This occurs especially during high winds or chilly and damp weather, as a result of wetting of the garments, and from insufficient covering at night. It is prolonged exposure in moderately low temperatures that is dangerous, rather than a short subjection of the body to a sudden cold shock. A cold douche or plunge is followed by vigorous contraction of the smooth muscle-fibers of the skin, driving the blood from the surface, while in prolonged exposure to slight cold there is no such reaction of the skin and a a large amount of blood is cooled slowly. This is especially true of those who have made themselves non-resistant and "soft" by excessive clothing or continued indoor life. Contraction of the muscles and vessels of the skin does not take place as readily in such persons as in hardy ones used to exposure and outdoor existence. Cold as a cause of catarrhal nasal affections does not seem operative in very pure air, as is the experience in Arctic exploring expeditions, so that the congestion of the mucous membrane caused by cold appears to need in addition microbic infection to produce the common "colds in the head."

To avoid catching cold it is needful to make the body resistant to the influence of cold. The cold shower-bath is of great value for this purpose. It may be used every morning or evening for from one to two minutes. The water should be cold enough to produce a decided reaction with the appearance of "goose-flesh" pimples on the skin. As the body-temperature and vigor are lowest in the morning, the evening shower is preferable for delicate people. Over-heated rooms and too much clothing are to be avoided. It is well to see that the sleeping-room does not cool down slowly over night, but that it is properly cooled at bedtime.

As is true of most other ailments, the **avoidance of nasal catarrh** involves also the keeping of the body in its best physical condition, when the nasal passages will resist irritants that in depreciated health they cannot withstand. This is especially so of the inhalation of irritants, such as dust or germs, which of themselves are not likely to cause nasal catarrh in healthy persons.

Although the healthy nose can dispose of dust and microbes so well, as soon as its mucous membrane is swollen and inflamed in consequence of catarrhal states it becomes liable to germ infection, so that in the last stages of acute catarrh of the nose, and in many cases of the same affection of a chronic order, we have a purulent secretion on account of pus-producing germs present in the nose.

The bacilli of diphtheria, tuberculosis, influenza and glanders, staphylococci and streptococci, and the contagion of measles and of scarlet fever are all liable to infect the nose, especially when the soil is prepared by a nasal catarrh.

It is possible to avoid **dust-inhalation** up to only a certain limit; but the amount of dust in households should be reduced to at least a minimum. The greatest dust-catcher is carpet, but curtains and drapery hold large amounts. It is in sweeping and dusting these articles that dust is distributed over the rooms and remains in the air for hours. It is known that the air of rooms contains many more microbes than that of the city streets. Those who have dusty occupations are often told to use a respirator, but these contrivances are generally so disfiguring that few can be induced to wear them, so that in this class there will be many victims of unhealthy respiratory conditions as long as employers do not supply pure air to their establishments.

The dry air of heated houses in winter is unfavorable to healthy conditions in the nose. The secretions become scanty, and the mucous membrane becomes dry, preventing the elimination of dust in the normal manner. The mucus forms adherent crusts which are liable to crack and be torn off, injuring the epithelial coating of the underlying membrane, and so opening the way to germ infection. This is especially the case if a slight catarrhal condition already exists. Erysipelas is sometimes caused in this way, the microbe of this disease entering the fissures and denuded places about the nostrils.

It should be regarded almost as important to supply moisture to the air of a house in winter as to supply heat, and until architects appreciate this fact, most persons will suffer rather than use such troublesome preventive measures as hanging moist cloths in front of the radiators, etc.

An atomizer containing a saturated solution of boric acid is a useful article in the care of the nose when the evil conditions—dust-breathing and dry heated air—exist. Its daily employment will relieve the dry irritated condition of the mucous membrane, and act as a preventive of nasal catarrhs by removing the excess of dust.

Picking of the nose is a very unhygienic habit. Most of the nose-bleeding in children is due to the finger-nail injuries of the mucous membrane of the septum, causing small crusting ulcers. Removal of these crusts is likely to be followed by nose-bleed. The hair-follicles at the nasal entrance are also liable to be infected by the finger, and boils result. All conditions which favor drying of nasal secretions foster the habit of nose-picking in children. A few drops of vaselin brushed into the nostrils of children will do much to prevent crusting, as all oils dissolve crusts.

Abscess and suppuration of the antrum of Highmore, the air-cavity in the upper jaw, is often due to decay of teeth whose roots project into the antrum. Care of the teeth is necessary to prevent this form of disease.

THE NASOPHARYNX.

The space back of the nose is called the nasopharynx. Its roof is formed by the base of the skull, its back wall by the vertebræ of the neck, its front by the posterior ends of the nostrils, its lateral walls by the Eustachian tubes, which project into the nasopharynx and supply the ear with air. A deep recess, called the fossa of Rosenmüller, lies back of the Eustachian tube and completes the lateral wall. The floor is formed by the soft palate, behind which there is an open space leading into the pharynx. This is closed when the soft palate is made tense and elevated. In children the greater part of the roof of the nasopharynx is covered by what is called the third, or Luschka's tonsil. The evil effects of enlargement of this tissue by **adenoid growth** have already been referred to as far as stoppage of respiration is concerned, but another important danger of this condition is pressure on the Eustachian tubes interfering with the ventilation of the middle ear—a common cause of deafness in children (see page 157).

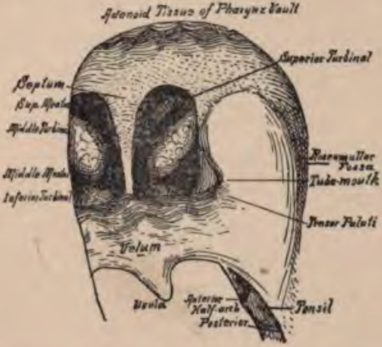

FIG. 23.—Pharyngeal tube-mouth, as seen by posterior rhinoscopy.

Habitual stopping up of the nose in children is therefore always to be taken seriously, as chronic deafness may result from neglect of this condition. The best treatment of enlargement of the third tonsil is its removal by operation. As it is a condition occurring in the hardiest and healthiest children, there seems to be no means to avoid its occurrence. In adults enlargement of the third tonsil usually disappears by atrophy, but not until the nasopharynx becomes the seat of frequent catarrhal attacks.

The catarrhal states of the nasopharynx are due to the same causes as those of the nose, and their prevention requires the measures already described. Catarrhal conditions of the nasopharynx should not be neglected, as they endanger the hearing by the possible involvement of the Eustachian tubes and middle ear. Deafness is also favored by nasal obstruction, as in such condition the act of swallowing causes a partial vacuum to form in the nasopharynx which sucks the air from the middle ear, drawing in its little chain of bones and stopping their vibratory motions.

THE OROPHARYNX.

Anatomy and Physiology.—Below the nasopharynx and continuous with it is the oropharynx, or part of the pharynx connecting with the mouth. It is directly visible through the mouth, while the nasopharynx is only visible by means of the laryngeal mirror and reflected light. The oropharynx is continuous with the cavity of the mouth, but is separated from it by the isthmus of the fauces, a narrowing caused by muscles which are continuous with the soft palate, and form what are called the anterior and the posterior pillars of the fauces. Between these lie the tonsils, also called faucial tonsils. The posterior wall of the oropharynx is continuous with that of the nasopharynx, and lies in front of the vertebræ of the neck. Its anterior wall is formed by the back of the tongue. The oropharynx is used for both respiration and swallowing. It is a part of the throat that is very resistant to disease, while the tonsils in front of it are, perhaps, more liable to infections than any [illegible] part of the body.

The tonsils are often enlarged as the result of chronic hypertrophy, and are then an obstruction to respiration and cause injury to the voice. Many tonsils that do not enlarge are subject to constantly recurring inflammation, due to repeated microbic invasion. An enlarged tonsil is especially likely to be the seat of diphtheritic infection, making it a constant menace to its possessor. The evil effects of enlarged tonsils on breathing and hearing are not nearly so marked as those of the enlarged pharyngeal tonsil. Nevertheless, the tonsils are often removed, as they are visible and easy of access, while the worse offender, the third tonsil, is left behind. In many persons the tonsils are frequently infected with pus microbes, causing repeated abscesses around them. Children suffering from enlarged tonsils often show a marked gain in weight and health after their removal, and in adults continually recurring infection necessitates treatment and often removal of the tonsils before proper hygiene of the throat can be practised.

The Tongue.—The back of the tongue is often covered with masses of thickened, decomposing epithelium, which may extend forward to the tip and cause visible "**coating of the tongue.**" It is this epithelium at the back of the tongue which is the cause of most cases of **bad breath** where there is no actual disease to account for it. Scraping off these masses from the back of the tongue, as far back as one can reach with the ring of one handle of a pair of scissors, removes this bad smelling material. Most persons do not know that the base of the tongue is often the site from which bad breath arises, and attribute it to catarrh. The cause of coating of the tongue, whether of gastric origin or due to some throat disorder, is, of course, a subject for medical treatment.

The laryngopharynx is the lowest division of the pharynx, and is situated behind the larynx. Below this it becomes the esophagus. It is not much subject to disease of a preventible order, but is a place of frequent lodgement of foreign bodies, fish-bones, and the like.

THE LARYNX.

The larynx is placed in front of the lowest part of the pharynx, and is composed of a number of cartilages. The largest of these, the thyroid, forms the greater part of the front of the larynx, and has somewhat the shape of a shield. Below and behind it is the cricoid cartilage, with which the thyroid articulates, being freely movable upon it. The cricoid cartilage has the shape of a signet ring, with the broad part of the ring behind. On the top of this broad portion rest two small, very movable cartilages, of pyramidal shape, the arytenoid cartilages. To the front end of these are attached the strong, band-like structures of white, fibrous material, called the rds, the instruments of sound for the voice.

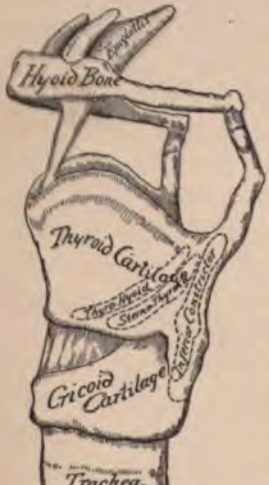

FIG. 24.—Lateral view of larynx in its relation to the hyoid bone and trachea.

The vocal cords are stretched between the arytenoid cartilages behind and the thyroid cartilage in front. They are attached in front and laterally to the thyroid cartilage, posteriorly to the arytenoid cartilages.

The larynx has many **muscles** of small size. Some of these move the cricoid backward from the thyroid cartilage in such a way that the vocal cords are made tense; others move the arytenoid cartilages so that they bring the vocal cords together, and others move these cartilages apart, so that the space between the

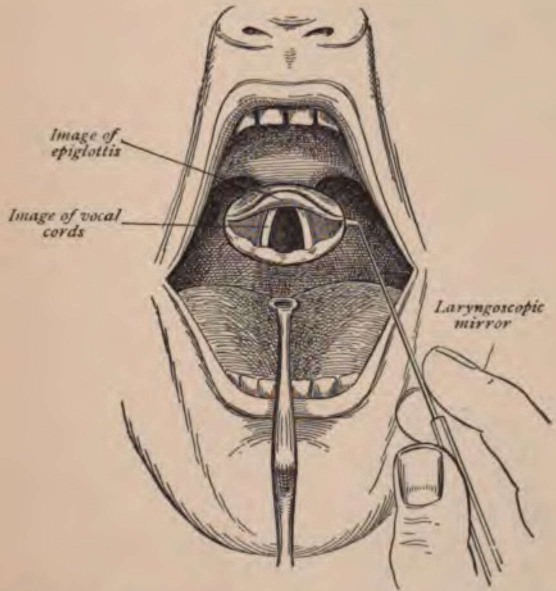

FIG. 25.—Schematic view of the tongue-base, epiglottis, arytenoids and ary-epiglottic folds, ventricular bands, and vocal cords, with the laryngoscopic reflection.

vocal cords, or glottis, as it is called, opens for breathing. If these last muscles are paralyzed the vocal cords come together and cannot open, so that there is danger of suffocation. There is a muscle seated in the vocal cord that regulates its tension and makes the wonderfully fine adjustments of the voice possible. It is called the musculus vocalis, or thyro-arytenoideus. For a more detailed description of the laryngeal muscles the reader is referred to works on anatomy.

In looking into a larynx with the **laryngoscopic mirror** (Fig. 25) the most conspicuous structures we see are the vocal cords, two white glistening bands extending forward and back. They stand wide apart at their posterior ends during quiet breathing, leaving a triangular opening, which permits a view down the trachea, or windpipe. When a sound is made the vocal cords can be seen to come together and touch each other with their inner borders. In front of and above the cords we see the **epiglottis**, a leaf-shaped structure which curls above the larynx, and is designed to cover it during swallowing of food or liquids. At the posterior ends of the vocal cords we see two

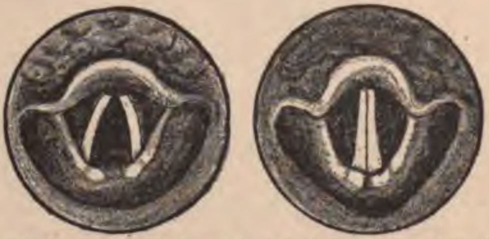

FIG. 26.—The laryngoscopic image in deep inspiration and in phonation.

roundish bodies, which move out and in with the cords. These are the arytenoid cartilages.

Functions of the Larynx.—During inspiration the vocal cords may be seen to move automatically apart, coming slightly together again during expiration. The larynx has, therefore, as its first function that of respiratory opening for the passage of air to the lungs, for which purpose it is needful that the vocal cords should be held apart by the proper muscles.

Another function of the larynx is to guard the lower air-passages from the entrance of foreign bodies. Even a small object entering the larynx causes at once a spasm of the vocal cords, that brings them together so tightly that nothing can pass them. This spasm may be lasting enough to cause symptoms of suffocation with blueness of the face; even death may occur before the spasm relaxes.

The most important function of the larynx is the **production of voice-sounds.** For this purpose three things are necessary: The bellows, supplied by the lungs; the vibrating membranes, the vocal cords; and the pipe, or trumpet, beyond them, supplied by the cavities of the nose, pharynx, and mouth. For the production of sound the vocal cords must be brought together and made tense by the laryngeal muscles. The higher the tone of the sound to be produced the more tense are the vocal cords, and the higher the larynx is raised in the pharynx, thus diminishing the length of the pipe, or tube, attached to the larynx, which has been likened to the part of a trumpet beyond the vibrating reed. For low tones the larynx is lowered or descends; thus the trumpet is lengthened. This raising and lowering of the larynx facilitates the production of high or low tones, but is not absolutely necessary, for by muscular effort the changes of pitch can be produced without change of the position of the larynx. This muscular effort, however, is a severe strain for the voice, and it will be referred to under the hygiene of the singing voice. The up and down motions of the larynx can be tested by any one who feels of the organ during the production of low or high notes.

The Production of Voice-Sounds.—While the pitch of the voice is mainly, therefore, furnished by the vocal cords, its timbre, or quality, depends chiefly on the pharyngeal, nasal, and mouth-passages. It is possible to permit the air to pass through the mouth only, when a sound is made, the soft palate shutting off the nose from the mouth, or the air may be allowed to go only through the nose, or through both nose and mouth together. Endless slight modifications of these conditions are possible, so that the voluntary changes in the quality of the voice by alteration of the position of the soft palate, lips, tongue, or pharyngeal muscles are innumerable.

So much do the shape, size, and position of the air-passages attached above to the larynx affect the quality of the sound produced that there are no two voices exactly alike, and individuals can be recognized by their voices alone.

For convenience we will call the oral, pharyngeal, and nasal passages above the larynx the attached tube. If the larynx is detached from this, as it is at times in cases of cut-throat, it makes a feeble sound only. This shows that the attached tube not only gives quality to the voice-sounds, but intensity as well, acting in this way similarly to a speaking-trumpet. The respiratory function of the larynx is interfered with only by actual disease severe enough to so narrow the air-passages as to cause shortness of breath.

The Care of the Voice.—A pleasing speech and voice are almost equal to personal appearance in importance to the individual in his relations to others. A great number of complex movements are needed to produce proper speech, and these are acquired slowly and with difficulty. In fact, a center for these delicate coördinated movements has to be developed in the brain as the child grows. Speech is largely the result of imitation, and if the voices a child hears are harsh or coarse so will its own become. The best way therefore to teach a child distinct and refined speech is to let it hear such only. However, this is not always all that is sufficient. Enlarged tonsils and, still more, adenoid vegetations block the way of the sound-waves to the nasal cavities after they leave the larynx. This deprives the voice of both intensity and resonance, and compels the child to adjust its laryngeal muscles and those of articulation to the strain thus thrown upon them. This interferes with the acquirement of the delicate coördination of the muscles needed for distinct speech, and such children usually have an imperfect utterance. The number of people that are allowed to grow up handicapped by hasty, slurred, harsh, disagreeable speech and voice is great. Parents do not seem to appreciate the advantage to their children in after-life that a refined, melodious voice will be.

Proper singing is one of the best modes of cultivating a pleasant speaking voice, even if the singer has no chance of anything more than a place in a chorus. It is a delight to hear a good singer speak, and often we can tell that a person is a singer simply from the speech. Improper singing is not only a distress to others, but soon ruins at least the singing voice.

Children should be encouraged to sing. It paves the way to singing in adult life, and as they are not self-conscious and not afflicted with improper "methods" they do not strain their laryngeal muscles, especially as the tunes they sing are within easy reach of their voices. This presupposes, of course, that there are no obstructions to the passage of sound-vibrations in the upper air-passages, such as enlargement of either the faucial or the pharyngeal tonsils. Of course, children with hoarseness due to laryngeal ailments cannot sing. Those with an imperfect ear for music may be improved vastly by persistent efforts to sing true. When a child's voice is changing, singing should be prohibited until the adult type of voice has been fully developed. This is true of girls as well as boys. Singing is an excellent form of respiratory gymnastics, and tends to develop a full, well-formed chest. In this way it acts as a preventive of lung-diseases.

Loss of the adult singing voice means loss of occupation to professional singers, and to amateurs the loss of a valued social quality. All singers know what uncertain possessions their voices are. Many voices deteriorate early, or, giving good promise at first, do not stand the training and lose their tone; and this is not without reason.

One of the first causes of voice-deterioration is imperfect general health. Feeble persons, with weak muscles and imperfect nutrition, cannot develop a good voice, nor can those maintain it whose health has failed. Being non-resistant to disease because of low general vitality, the part put upon the greatest strain, the larynx, is subject to repeated catarrhs and to early fatigue in singing. This strain of the muscles of the larynx soon results in loss of the singing voice.

A second prolific cause of loss of the singing voice is persistence in singing during attacks of acute laryngitis, a persistence often rewarded with the chronic form of the disease. There is thickening of the mucous membrane, interfering with the action of the laryngeal muscles, hindering approximation of the cords, and causing the muscles to be used too energetically in order to overcome the abnormal resistance, so that their delicately fine adjustment becomes quite disordered. In such cases the singer's notes become untrue in pitch. During attacks of laryngitis the voice should have as nearly perfect rest as possible. Neither should a singer use his voice during an attack of cold in the head, as the abnormal obstruction to the sound-waves caused by the swollen mucous membrane of the nose disturbs the adjustment of the laryngeal muscles.

The commonest cause of voice-injury is **improper method in singing.** A singer with proper control of his voice adjusts the vocal cords and the attached tube so perfectly by exact muscular action that not only is no power wasted, no muscle made tense that is not necessarily so, but also the proper position is attained at once, so that the moment the bellows (lungs) force air through the larynx, the exact pitch and loudness desired are attained and held. In other words, the voice-muscles of a good singer are as perfectly under his control as are the muscles used in keeping the balance of an expert in bicycling. As with other muscles, those of the larynx subjected to excessive action tend to become strong and slow, while delicate adjustments are lost. In other words, they become, as gymnasts say, muscle-bound. All improper modes of singing include needless strain of the voice-muscles, and so interfere with their exact adjustment and cause them to contract too forcibly, so stiffening their action.

One of the worst faults is a rigid position of the larynx, its up and down motion being inhibited, producing a **"throat voice."** This involves tense contraction of many muscles that should be relaxed, and thus compels them to work under great disadvantage. One can hardly believe that this imperfect method of singing with suspension of the normal up and down motions of the larynx is a part of a "method" taught by certain vocal instructors. A disagreeable tremolo is one of the bad effects of singing forte under these conditions, and an annoying forced or pressed sound of the voice also results. Another of the evil effects of this strained way of singing is chronic laryngitis with thickening and excrescences of the vocal cords. This is true of any other improper and strained mode of using the voice, though the resistance of the larynx to abuse varies. A voice which is used out of its normal register, especially if there is a constant straining after high notes, is one that will not last long.

Singing-teachers commit great errors in yielding to the ambitions of pupils, or in not being careful enough in determining the normal voice in question, allowing altos to attempt to be sopranos, and baritones to try to become tenors, etc.

Excessive use of the voice threatens its integrity, as do attempts to sing difficult music before the voice has been sufficiently trained. The action of the laryngeal muscles differs from that of many others in that they are continually and with great exactness adjusting the position and tension of the cords, and holding them in certain positions. This renders them especially liable to injuries after prolonged fatiguing contractions. In order to sing well and long, careful practice is needed until little by little the muscles learn their exact adjustments. By improper use of the voice it may become irretrievably damaged and even actual disease of the larynx may result. No one should sing until the larynx becomes fatigued, but an attempt should be made by easy stages to strengthen the voice-muscles until they acquire more endurance.

Many persons in speaking or singing are likely to begin the vocal sound sforzando with sudden emphasis. As this implies bringing the vocal cords together with spasmodic force, such practice not only produces a disagreeable vocal sound, but irritates the free borders of the vocal cords, rendering them liable to the occurrence of small prominences, called **singers' nodes,** which interfere greatly with the clearness of the voice. This spasmodic action of the vocal cords is called the "coup de glotte."

Some strong, robust people with good natural voices attempt by sheer muscular effort to overcome their defective vocal education. As these individuals have not learned to co-ordinate their laryngeal muscles for proper united action, the result is a disagreeable tremolo. Persons with weak physique and imperfect development should strengthen themselves by calisthenics and breathing-exercises before beginning to sing. Attention to the general nutrition of the body is also needed. Those who have lost much weight or have not fully recovered from exhausting ailments should not sing. Here it is that the modern method of forced feeding, having the patient limit his daily amount of food not by his appetite, but by his digestive powers, is of great value. There is no doubt that a great many of the thin individuals of the community suffer from self-imposed starvation, as their appetites from nervous causes fail and their sense of hunger is lost, while their digestive powers are unimpaired. If these were made use of to their limit, they would bring a return of weight and strength. Constricting garments, especially corsets, should not be worn, as they interfere with the chest-expansion, the sustaining of tones, and the regulation of the air-current supplied by the respiratory muscles.

The manner of using the vocal organs in practising singing is, of course, a matter best left to singing-teachers; but as these are not all competent, an attempt has been made to furnish some knowledge as a guide to those who desire to sing, knowledge which it is hoped will help them to tell whether or not they are in good hands when they begin to take singing-lessons.

THE CHEST AND LUNGS.

The hygiene of the respiratory organs within the chest includes a consideration of the thorax, the respiratory muscles, and the lungs.

The thorax, or chest-cavity, is formed by the attachments of the ribs, their costal cartilages, and the sternum, to the spinal column. The latter is the fixed base to which the other movable parts of the chest are fastened. The part of the spinal column to which the thorax is affixed includes the twelve dorsal vertebræ. Twelve ribs on each side of the body are joined to it, their heads forming joints with the bodies of the vertebræ, while their necks rest on the strong

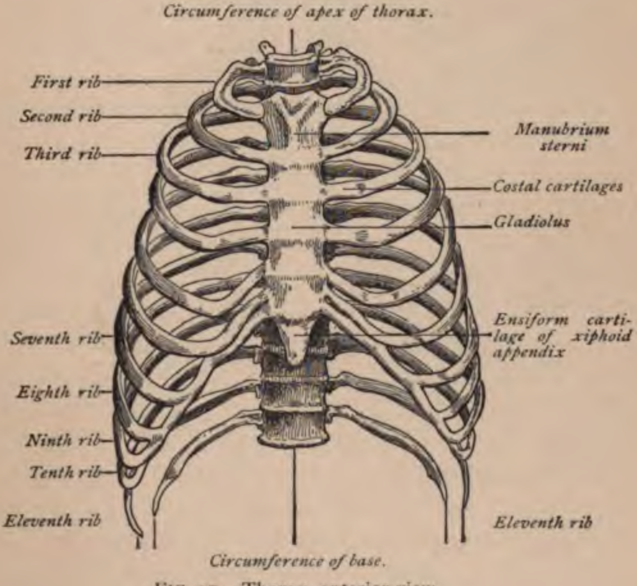

FIG. 27.—Thorax, anterior view.

vertebral transverse processes, moving upon them and being attached to them by another joint at the tip of the transverse process. The ribs end in front in the costal cartilages, which are really elastic prolongations of the ribs. The costal cartilages of the first seven ribs join the breast-bone directly; those of the next three ribs are joined to the costal cartilages above; while those of the last two ribs are unattached and form what are called the floating ribs.

The breast-bone, or sternum, closes the thorax in front and moves with the ribs, forming with them a movable cage enclosing the lungs.

The muscles of the thorax are the intercostals that fill the space between the ribs and complete the chest-walls; the diaphragm, which closes the cavity of the chest below, separating it from the abdomen; and the auxiliary respiratory muscles, or muscles of forced breathing, which, however, are not in use during quiet breathing. These auxiliary muscles are the scaleni, arising from the neck vertebræ and inserted into the upper two ribs; the sterno-cleido-mastoid muscles, arising from the skull and attached to the clavicle; the pectoralis minor, arising from the scapula and inserted into the third and fourth ribs; and the serratus posticus superior muscle, arising from the spinal column and attached to the ribs.

The muscles that are used for forced expiration are the abdominal muscles, the serratus posticus inferior, attached to the spine below and reaching up to the ribs, and the quadratus lumborum muscle, which takes its fixed point from the pelvis and pulls the ribs downward.

The only muscles in use during quiet breathing are the intercostal muscles, the diaphragm, and the levatores costarum longus et brevus muscles. These are all muscles of inspiration. Ordinary expiration requires no muscular effort at all, as the weight of the thorax and the elasticity of the lungs give sufficient power to contract the thorax and expel the air, the ribs dropping back into the expiratory position after being lifted by the inspiratory muscles.

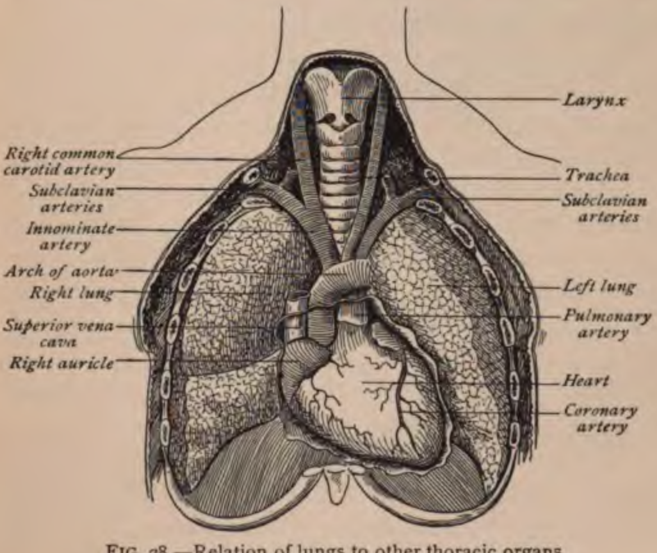

FIG. 28.—Relation of lungs to other thoracic organs.

The lungs are composed of an immense number of little air-cells, or alveoli, which connect with the outer air by means of the **bronchial tubes.** These begin as tubes of microscopic size, which unite to larger and larger ones until they enter the windpipe, or trachea, by means of a large bronchus, or air-tube, for each lung. The larger bronchial tubes are stiffened with rings of cartilage, and the smaller ones down to a caliber of one millimeter with cartilaginous plates. The smallest bronchial tubes have only circular muscle-fibers instead of cartilage. The air-cells, or alveoli, are coated with thin pavement-epithelium and have the greater part of their walls composed of a dense network of capillary blood-vessels.

The function of the air-cells is to allow the red blood-cells to absorb oxygen from the air and give off the carbon dioxid which they hold partly in chemical combination and which is partly also contained in the fluid blood. The lung is therefore a gland designed to take in and excrete the gaseous constituents of the blood. The red blood-cells do not simply absorb the oxygen of the air, but take it into loose chemical combination with their pigment of hemoglobin. This in turn delivers the oxygen to the tissues of the body. The blood passing through the capillaries of the air-cells comes from the pulmonary artery and right ventricle of the heart, and is venous blood while in this vessel. It leaves the capillaries lining the air-cells to enter the pulmonary veins as arterial blood, or blood which has taken up oxygen. The lungs have a further blood-supply for their own nutrition, as that which passes through the capillaries of the pulmonary artery is not utilized by the lung itself, but is utilized merely for the purpose of oxidation. The arteries supplying the lungs with nutrient blood are called the bronchial arteries, and are branches of the aorta.

The walls of the alveoli of the bronchial tubes and of the interstitial tissue between the lobules, or clusters of air-cells, at the end of a bronchiole, or minute bronchus, are all composed largely of what are called elastic fibers. This gives to the lung its rubber-like power of elastic retraction after expansion.

The lungs are not attached directly to the chest-wall, but are covered by a smooth glistening membrane called the **pleura.** A similar membrane lines the inside of the chest-wall, and though the lungs lie in contact with this wall they are not attached to it, as the layer of the pleura covering the lung, while in touch with that lining the chest-wall, nevertheless glides smoothly upon it during the respiratory motions. If the chest-wall is perforated, the lung collapses by reason of its own elastic retractility, air meanwhile rushing into what is called the pleural cavity between the two layers of the pleura. In health, of course, there is no cavity, as these layers lie against each other.

The lungs are kept expanded by the suction of the chest-wall, and in health never entirely collapse. The inspiratory muscles lift the ribs upward and outward, thus increasing the capacity of the chest in its circumference, while the diaphragm descends, increasing the capacity vertically. This causes an increase of the negative pressure in the chest; and as in health air cannot enter the pleural cavity, the lung must follow the pulling force of the expanding thorax and fill with the air that rushes into the trachea.

Ordinary expiration takes place, as stated, by means of the retractile power of the lung and the weight of the chest-walls, no muscular effort being needed.

It is obvious that when expanding the lung must not only suck in air into its air-cells, but also must draw blood into its capillary vessels. The narrower the orifice through which the air passes the more power is left to suck in blood, so that nose-breathing is an aid to the circulation of blood in the lung, while mouth-breathing is not. The thorax loses mobility and expanding power in later life, and in the aged becomes stiff and rigid. The motion of the ribs in their sockets becomes limited, while the elastic costal cartilages, which are twisted or undergo torsion during each inspiration, normally become too stiff to yield in this way to the inspiratory pull. Age therefore disqualifies for violent exertion, as this rigidity of the thorax gives the respiratory muscles more work to do, and breathlessness comes sooner during exertion in age than in youth. By continuing gymnastics and respiratory exercises through life the greater part of the mobility of the thorax can be maintained till a very advanced age. This is an argument against the theory that after youth is passed, gymnastics are of no use.

Deformities of the Thorax.—The highest efficiency of the lungs as organs of blood-oxygenation demands a well-formed thorax; yet it is precisely the thorax that of all parts of the skeleton is most often deformed, a fact which accounts in part for the frequency of lung-diseases.

The chest is simply an air-pump, and if its capacity is diminished by being bent out of shape it can obviously suck in less air than is necessary. This is also the case if its movements are restricted.

In the extreme chest-deformity of **hunchbacks,** in which in parts of the chest there is no movement at all, we find portions of the lung entirely unexpanded, forming simply a fleshy mass. This example of great deformity shows how in a less degree the commoner deformities of the chest hinder the proper expansion of the lungs, especially within the parts most deformed.

The most frequent chest-deformity is **scoliosis, or lateral curvature of the spine,** with twisting of the whole spinal column to one or the other side, usually the right. In this form of deformity the shoulder is lower on one side than on the other, and the relatives and teachers of the child or youth so deformed tell him to lift his shoulder and stand "straight," imagining that the deformity is in the shoulders. Scoliosis contracts the side of the thorax toward which the spine is twisted. There is ordinarily another spinal deformity associated with scoliosis, called **kyphosis,** or bending of the spinal column forward, producing a thorax rounded behind and flattened in front—the typical, flat-chested, round-shouldered person which is so often the product of our schools (see page 238). Even the laity know from sad experience that this form of chest predisposes to consumption.

The effect of the kypho-scoliotic thorax is deficient expansion, especially of the apex of one lung, rendering it very liable to tubercular infection. This deformity originates chiefly in school, on account of fatigue of the muscles which maintain the spinal column in the erect position. As they relax from weariness due to long sitting at the desk the column of vertebræ bends forward and rotates toward one or the other side. When this is often repeated and kept up for hours at a time from compression the growing bones become permanently misshapen, and deformity results which lasts through life. Kyphosis, however, may exist without scoliosis.

The prevention of spinal deformities requires, in the first place, seats that will permit a child to rest his spine in the proper position of erectness. The plane of the book's surface should be placed, if necessary, by special desk-attachments almost parallel to the plane of the child's face, so that he can read while sitting erect without bending over his desk. The possible factor of astigmatism at oblique axis in the early development of spinal curvature should not be overlooked.

Interruptions of study by calisthenic exercises designed to give vigor to those muscles that counteract the evil, deforming effects of prolonged sitting should occur every half-hour, and be continued for five minutes at a time. The muscles that hold the spine erect and give it lateral support are the ones to be especially strengthened in this way. Deformity invariably results whenever muscular support is removed from any part of the skeleton, as the ligaments which unite the bones stretch under strain, for they are simply limiters of excessive motion, not supports of the skeleton like the muscles. The spinal muscles are quite independent of those that move the shoulders. It is useless to tell round-shouldered persons to draw their shoulders back; this will not straighten their backs. The shoulders and shoulder-girdle, composed of the clavicles and scapulas, are only secondarily displaced by the spinal deformity, and have little to do with an erect carriage. The spinal muscles, chiefly the erector spinæ, are the ones to be exercised while the shoulders are being held loosely and in a state of relaxation.

"Shoulder-braces" are absolutely worthless contrivances, which not only do not take the place of the spinal muscles in holding the spine erect, but make their wearer stiff and ungainly in his motions. After growth is attained much can be done at least to partly overcome those spinal deformities the correction of which has been neglected during growth. Development of the spinal muscles is also indicated, but will not accomplish as much as in the growing period. In overcoming the deformity of scoliosis rotary motions of the spine in a direction opposite to its natural faulty twist are indicated.

Symmetric chests without actual deformity may be narrow and of limited capacity, with deficient expansion. The tendency to this form of chest should be counteracted in growing years by special attention to **respiratory gymnastics** and light exercises, such as sparring, running, etc. In adults, though the bony frame of the chest is unchangeable and the number of air-cells in the lungs is unalterable, breathing-exercises will cause the limited excursions of the ribs in their joints to increase, adding thus to the amount of air exhaled and inhaled, and making the chest larger in full inspiration, when air-cells heretofore only half expanded become fully so. The chest becomes more roomy because of the greater motility of its parts, not because there is any increase in their size.

The fact is so universally appreciated that the flat and narrow chest with wide intercostal spaces predisposes to consumption of the lungs that it is called the **"phthisical thorax."** Pulmonary tuberculosis is found much less often in persons with well-formed chests, as all parts of the lungs are equally expanded and kept healthy by use; while in the flat, narrow chest the upper parts of the lungs, or apices, get little expansion, and experience shows that these portions are especially liable to tubercular infection.

The purity of the air inhaled is next to a well-formed chest in importance to the health of the lungs. Nature tries to make the air dust-free before it reaches the finer bronchial tubes and alveoli, but in spite of the many safeguards some **dust** penetrates the air-cells. In addition to the upper air-passages, which arrest most of the dust, the bronchial tubes, branching angularly, catch nearly all that remains before it enters the finer bronchioles and air-cells. The dust so caught is moved into the outer world again by the ciliated epithelium of the bronchi. Excessive amounts of dust irritate the larynx and trachea, and cause coughing-fits which expel the noxious particles. Only when the secretions are excessive is coughing needful to keep the lungs clear; otherwise a balance is maintained between the supply of mucus to the bronchi and the amount needed. The dust which reaches the air-cells is taken up by the leukocytes, or white blood-cells, as they are called, and carried by the lymphatic channels to the bronchial lymph-glands, where the dust is deposited. Microbes entering the air-cells are carried off in the same way, and are liable to excite inflammation and abscess of the bronchial glands. This occurs so rarely, though, and these glands are so very tolerant of large amounts of dust, that they may be regarded as a very perfect safeguard to the lungs.

Coal-dust and vegetable-dust are the least harmful to the lungs. The dust of metals and minerals, if inhaled long enough, is one of the chief causes of fibroid phthisis. The methods of avoiding dust-breathing have been considered sufficiently in that portion of this chapter referring to nasal hygiene.

Virulent microbes are being constantly inhaled; but only under conditions of impaired resistance due to lowered vitality or local disease in the lung are they liable to attack the individual. The **diplococcus of pneumonia,** for instance, which is present in the mouths of many people and is often inhaled, is likely to cause pneumonia if the person who has inhaled it has had a severe chilling.

The influenza bacillus is a germ that seems capable of causing disease in almost all persons; but the infection varies greatly in severity, the aged especially being liable to the grave pneumonic forms of influenza.

The bacillus of tuberculosis, which we doubtless often inhale into our lungs, in those of lowered vitality may cause pulmonary tuberculosis, called also **consumption** of the lungs or **phthisis.** Again, there may be a special predisposition to tubercular disease in some individuals which makes them particularly liable to be attacked by the microbe even when in good health. This predisposition to infection by the bacillus of tuberculosis may be noticed in certain varieties of animals, the ruminants, as a rule, being more liable to tuberculosis. A damp soil favors the development of tuberculosis.

Prevention of Tuberculosis.—It is impossible to avoid inhaling the germs of disease into the lungs at some time, but the danger of infection may be diminished by care on the part of those already infected.

It is known that the **sputum, or expectoration, of tubercular patients** should always be deposited in fluid and not allowed to dry. If the sputum dries on the floor or in handkerchiefs, it is likely to be pulverized and float about as dust. Thus inhaled, it is a means of spreading tuberculosis. The sputum, therefore, should be caught in a vessel containing fluid which dissolves the tough mucus, the best being a solution of lye. A stronger disinfectant, such as 5 per cent. aqueous solution of carbolic acid, may also be used. In spite of care, sputum may lodge on the edge of the vessel, so that this should be protected from flies, as they may carry the bacilli about and infect food or light on wounds. Patients who go out of doors should carry cloths to cough into, or a paper-bag which can be burnt with the cloths. Of course, most patients will deposit their sputum on the street, not heeding the danger in which they place the public. Fortunately, sunlight and the open air soon render harmless bacilli deposited out of doors. Patients in the last stages of the disease, too weak to use a sputum-cup, should have a large pan into which they can drop the cloths they use to catch their sputum. These cloths are, of course, to be burned. It is especially by these patients who are near death that the bacilli are spread, as precautions are little observed by either patient or attendants at this time.

The patients should be taught to take these precautions for their own sake, as they are likely to infect healthy parts of their lungs or the larynx by inhaling bacilli derived from their sputum. A room in which a tubercular patient has lived should be repeatedly and thoroughly disinfected with formalin, which is best made in large generators, which convert a half gallon of wood alcohol into formalin vapor in a short time, so insuring concentration. At the same time the air of the room should be made very moist by hanging up a number of wet sheets.

Lately it has been claimed that in coughing and even in speaking tubercular patients eject into the air minute particles of saliva containing bacilli. During coughing this probably occurs to a slight degree at times; but, on the whole, this source of tubercular infection is very unusual and does not justify compelling consumptives to wear cloth masks to catch bacilli, as has been suggested. During coughing, however, a cloth should always be held in front of the mouth.

The sputum of patients with influenza, pneumonia, or bronchitis should be disposed of in the same manner as that of tubercular patients, as the discharges from the lungs in these diseases also contain pathogenic germs.

The freedom of the lungs from disease more than most organs depends on the **maintenance of a high standard of bodily health.** The lungs especially become vulnerable to the causes of local disease on account of poor nourishment of their tissues due to low vitality. Children of the poorer class, often ill-fed and living in badly ventilated rooms, are more liable to pulmonary and bronchial affections than those living under better circumstances.

Natural immunity plays a great role in preventing tubercular disease in many whose ill-health would otherwise render them liable to consumption; but those who have even a strong hereditary predisposition to the disease can usually avoid it by keeping up a robust state of health. On the other hand, many have their natural immunity destroyed by certain depressing causes, especially by **alcoholism** and diabetes. Habitual drinkers bring upon themselves a disposition to tuberculosis even while their appearance remains robust and their weight normal. Excessive use of alcohol seems to neutralize natural immunity to the disease. The vital depression which comes on with advancing age, however, is accompanied by a tendency to the formation of fibrous tissue, which toughens the lungs and renders them less liable to consumption. When the disease occurs in elderly people it is likely to assume a slow and relatively benign type.

Physical training of a tubercularly inclined youth should receive as much care as his mental development. Every observer sees children well developed mentally who are in greatest need of physical development for their feeble, light-boned, flat-chested bodies; bodies that must serve them through life, a perpetual hindrance to success and effort, and which are the cause of premature aging and invalidism. It is only during the growing years from twelve to twenty-four that physical training is of avail, and it is strange that parents appreciate so little this promoter of the health and beauty of their children. Though we meet with some remarkable minds in feeble bodies, ordinarily these minds are of the receptive order, which take in facts readily but do not possess the power to elaborate or apply them.

The functions of the heart and lungs are intimately connected, and it is necessary to mention their relations in considering this subject. Proper development of the muscles of the body implies not only a strongly developed set of respiratory muscles, but also a strong and enduring heart. The function of respiration is a great aid to the heart in maintaining the circulation, each inspiration and expiration forcing blood as well as air into and out of the chest. A well-developed thorax, with wide respiratory excursions, is therefore a great aid to the heart in its work.

Exercises requiring increased breathing should be performed with deep inspiration and expiration through the nose. The expiration should be watched especially, as the tendency is to keep the lungs full of air without emptying them properly, so that many athletes suffer from acute emphysema, or dilatation of the lungs. All exercises causing slow powerful contractions of many muscles, as lifting great weights, wrestling, part of the work done on the horizontal or parallel bars, tend to develop powerful, large, but slowly-acting muscles, and throw a strain on the heart, because respiration during these acts is either suspended or limited while the thorax is held rigid. The chief cause of acute heart-strain or dilatation of the heart is sudden, severe muscular effort. These exercises are to be avoided or attempted in moderation, and only by the robust. They are certainly of little use to those who wish to develop the thorax, as the respiratory excursions are too limited during them.

Another class of exercises tending to one-sided muscular development and physical strain are those requiring prolonged muscular efforts, such as long-distance cycling, rowing, or running. In moderation these are all of benefit, but the tendency to overdo them is great. Of the three, running is by far the best, as the thorax is not held rigidly as a base for the attached muscles, but is free and unrestrained in its motions. Running, when properly performed, is one of the best of all exercises. In riding the bicycle it is highly important that the breathing should be deep, full, and through the nose. It is especially in this form of exercise that heart-strain is likely to occur, largely because the thorax is held rigidly and the breathing is shallow. A heart which has once been strained and dilated by imprudent exertion may apparently regain its vigor, but it is usually liable to a recurrence of the affection on moderate exertion, and so remains a weak organ.

The best exercises for developing an enduring and robust body are general calisthenics, the so-called "army setting-up drill." Sparring, vaulting, hand-ball, and all work of this light, quick class are to be commended. Swimming also is a fine respiratory and free-motion exercise. In fact, all those exercises furnishing unrestrained and easy motions are preferable to feats of strength or endurance. No exercise should be continued until it becomes a physical strain. Although the two may be easily combined, sport is not physical culture, for the latter is not to be pursued for amusement only, but as a serious duty to one's self and others. No one should neglect his bodily vigor.

The Influence of Climate on Consumption.— Those with very strong tubercular tendencies had better seek a proper climate for their permanent home early rather than postpone the change of residence until the appearance of the disease. Considering the fact that whole families die of consumption, one after the other, this preventive measure seems fully justified. A move from the large city to the neighboring suburbs is often of benefit.

The chief requisite of a good climate is the opportunity it offers to live out of doors as much as possible. Certain climates are often looked upon as specific cures for consumption; but the disease originates *de novo* in any climate, and its course is influenced favorably by proper hygienic measures in all climates. We must not overestimate the effect of the special region in which the patient is placed, though high and dry localities undoubtedly have a favorable influence on the course of the disease.

Adjuvants to Climatic Treatment.—In addition to avoiding as much as possible the chance of infection with the bacillus of tuberculosis, persons predisposed to consumption should give the greatest care to their bodily nutrition and keep their weight up to the normal standard by judicious feeding with plain fare—meats, and especially bread and butter. They should avoid gastric pleasures that give but little nourishment to the organism and only contribute to disorder digestion. Reference is especially made to alcoholic drinks and coffee, to excess of sweets, fruits, pies, and the like, and to drinking of large amounts of ice water, causing atony and dilatation of the stomach. Chronic nicotin-poisoning, fast eating, taking fifteen minutes to a meal instead of forty, violent exercise causing heart-strain, all are factors that lower vitality and which should be avoided by those predisposed to consumption. A hygienic life and a dry soil are far greater safeguards against the disease than the false sense of security furnished by a certain climate. Keeping up the body-weight, maintaining the muscles hard and firm, and the heart strong by exercise, and good food are safeguards, and all but those greatly predisposed to consumption may feel reasonably sure of escaping it if they do not neglect them.

Division of climates may be conveniently made by levels.

The sea-level, the lowest, furnishes a high atmospheric pressure which necessitates only moderate lung-expansion during exercise. The air is germ-free and dust-free when the wind is on-shore. The appetite, nervous system, and tissue-change are stimulated. However, high winds prevail, and experience shows that this is not a good climate for consumptives.

The low levels, up to 1200 feet, lack the tonic properties of the higher levels or the sea-level. The temperature-changes from night to day are moderate. On the whole, these climates are not suitable for consumptives, nor for those who are relaxed or run down and need stimulation.

The moderate levels, 1200 to 3000 feet, are excellent for delicate people who need stimulation of their nervous system and appetite, but who would find it hard to endure the great changes in temperature and the difficulty of exertion connected with life in the higher altitudes, which require a strong heart and well-developed respiratory muscles. Moderate levels are therefore better for older persons with more or less rigid chest-walls. The air in these regions is relatively pure.

The higher levels, above 3000 feet, give the effect of low air-pressure; the air is rarefied and much colder at night than in the daytime. Differences in temperature are sudden and extreme. The air is usually dry and germ-free. The amount of blood passing through the vessels of the skin and lungs is increased; the rarefied air makes freer respiratory movements of the chest needful. More water and heat are lost from the body, causing greater tissue-change. Such climates are suitable for the more robust, with good digestion, in whom the losses due to rapid tissue-changes can be readily replaced. On the whole, the high altitudes are the best for a person predisposed to consumption, provided he is not delicate and nervous, or that age has not made his arteries rigid and his thorax non-expansile, and that his heart is sound.

In making a change of climate one should always consider whether the conditions in a strange place will be as good as those at home. Many consumptives would have fared better at home than in a more suitable climate than their home can offer if connected with this new climate there are a lack of nursing and badly cooked food at some boarding-house or hotel. For those who seek new climates to avoid acquiring consumption it is of first importance that in their new surroundings they be well fed and have healthy, airy rooms and suitable occupations. It would be a poor move for a man living a healthy out-of-door life in Illinois to assume an unhealthy indoor occupation in Colorado.

It is likely that the greater expansion of the lungs with air and the better blood-supply due to deeper respiration have much to do with the good effects of the higher altitudes on the slower and milder types of consumption. This influence is liable to be positively unfavorable in rapidly advancing cases with fever, when both body and lungs need rest. In such cases the treatment by perfect rest in the open air in the recumbent position, with feeding up to the full limits of the digestive powers, is the best treatment, and accomplishes more than a change of climate.

THE HYGIENE OF THE EAR.

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THE hygiene of the organ of hearing—as of each organ of the body—depends largely upon its anatomy and physiology. The essential part of the organ—the nervous apparatus by which the sound-waves are received and conveyed to the perceptive centers—is so deeply placed as to be out of the reach of most direct influences except those which affect the whole body; but the accessory or conducting apparatus is open to many injuries and affections which may be warded off by hygienic rules such as may be considered strictly aural. These rules are more often negative—the forbidding of common but pernicious interferences—and may be summed up in a brief "let alone," as will appear in the detailed consideration of the subject. Leaving the internal or percipient portions of the ear for later consideration, we are primarily concerned with the external and middle portions, and can be free from some usual misconceptions with regard to these only by studying them in some detail.

THE EXTERNAL EAR.

The Auricle.—The external ear is a moulding in and out of the skin-surface, and is governed by most of the rules pertaining to the general cutaneous system. It comprises the projecting auricle and the depressed canal, an irregular tube which penetrates more than an inch nearly directly inward. Apart from its liability to injury, frost-bite, and skin-affections, the auricle is unimportant, and its total loss does not appreciably affect the hearing and merely causes an unsightly deformity. Its undeveloped conditions are often accompanied by absence or incompetence of more valuable deeper structures, to which any defect of hearing is really ascribable. The auricle might be passed with mere reference to the need of slow thawing after **frost-bite** but for the need of a few words as to the barbarism of wearing **earrings**. Fortunately, fashion is rather setting her face against them; but this is little felt as yet in the lower walks of life, where the tradition that piercing the ears is helpful to sore eyes also is strong. This latter superstition is the basis for the not uncommon wearing of earrings among sailors. This is wholly specious unless, as with the seton of the older surgeon, a strongly coun-

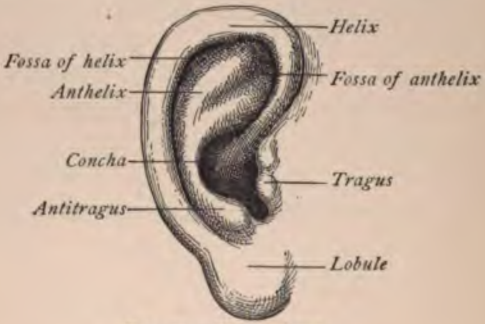

FIG. 29.—External ear.

ter-irritating sore is produced, but this is an obsolete measure wholly superseded by more rational surgery. Too often the piercing of the ears has been entrusted to some ignorant peddler of earrings, and a single group of children will furnish many cases of abscess, more or less severe, resulting from his use of an infected needle. Severe blood-poisoning may not be usual, but some deformity is likely to result. Especially in the colored race, a fibrous enlargement, or "keloid," may arise without decided septic infection, may grow even to the size of the fist, and recur in spite of skilful removal by operation. Such results are often ascribed to the earrings being too heavy or composed of base metal; and the rings rather than the primary piercing are blamed for the consequences that follow.

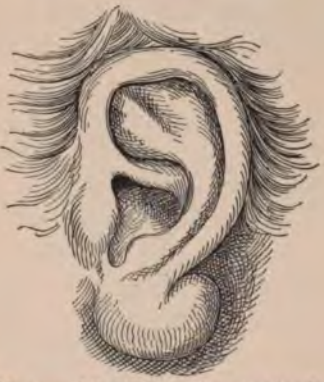

FIG. 30.—Abscess of the lobule after piercing for earrings.

Of decided interest also is the **blood-cyst, or "hematoma,"** of the auricle, most commonly due to injury in sparring, foot-ball, etc., but occurring also without known cause, especially in the insane. Some have even held that the formation of such a blood-cyst may be prophetic of mental trouble not yet apparent. Often painless and stubborn, they may leave much deformity, since the cartilage of the ear depends for its nutrition upon the fibrous tissue which covers it, and this is lifted away from its place by the effused fluid being poured out between them: softening and shrinkage are therefore likely to follow the tardy cure.

The hygiene of the auditory canal or meatus is more special. Here we have a skin-lined pocket more than an inch in depth, with the drum-head at its bottom and its walls supplied at the outer part with hairs and glands. The narrowness and curvings of the canal serve to keep out foreign bodies—even dust being arrested by the hairs, which act like a sieve, and by the wax-covered walls.

The ear-wax, or cerumen, is a thin yellowish fluid formed by glands strictly like the sweat-glands of other skin-surfaces. It thickens into a yellow paste as it dries and unites with the little flakes of dead skin, and it tends to dry and fall outward. As the glands are only in the outer two-thirds of the canal, no wax forms on or near the drum-head, and when found in this vicinity it has been pressed there by meddlesome interference. All skin-surfaces are constantly shedding the dry dead cells of the outer layer; but this should be more imperceptible on the fine skin of the ear-canal than elsewhere. Yet the finest scales might interfere with the delicate function of the drum-head; so by a remarkable provision of nature its cells grow so much faster at the center as virtually to overflow the rest of the surface, pushing the other cells before them over the edge on to the adjacent wall, and even some distance along this before they are thrown off. Thus the drum-head keeps itself clean, and may be said even to sweep the neighboring canal-walls of the effete material loosened from their surfaces. Then the wax begins to gum into scales this dandruff-like material, and with the help of the stiff little hairs, which tend to get caught under it, it is worked toward the external opening. The movements of the jaw act upon the outer part of the canal, as is easily felt by a finger thrust into the ear, and furnish power enough to move large flakes of wax outward, or even to eject them upon the shoulder. Thus a healthy ear should never show much more than enough wax to render sticky the hairs within it, and the owner should be unconscious of any wax coming away.

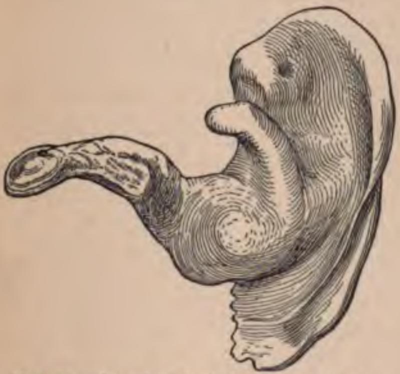

FIG. 31.—Metal cast of the external ear, showing the curves of the canal.

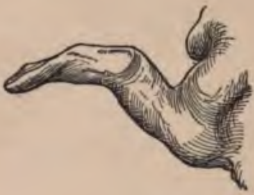

FIG. 32.—Cast of the canal in profile.

Wax does not collect in a healthy ear. No appliance is called for to remove it, and all such are to be condemned. Yet the penetration of water in bathing or other unnatural conditions may serve to agglutinate the wax into masses that do not come away naturally, and collections may take place, especially in ears not healthy. This may indicate lessened rather than increased wax-formation, although the accumulation may seem astonishingly great when brought to light. Often it is in those who take the most (misguided) pains to keep their ears clean with scoops or mops that we find the largest and hardest masses. In hospital clinics, coal-heavers and others employed in dusty work constitute a large number of the ear-cases showing this condition.

Efforts to remove collections of ear-wax are likely to be dangerous and futile, and should be entrusted only to the skilled hand; although the ease and safety with which the expert syringes them away may make his fee seem too easily earned. Only those who see how much harm is frequently done by the inexperienced can realize that the value of such service lies as much in what is avoided as in the good work done. Collecting gradually for months until only a small slit alongside the mass admits the sound-waves to the ear, the entrance of a little moisture or even of damp air may swell the wax enough to close suddenly all passage-way and cause sudden deafness, with perhaps dizziness, nausea, cough, or other curious and at times most distant extraordinary symptoms. These may pass away as the wax dries and shrinks, only to return under similar circumstances of com-
ness of closure. Pain is not usually a part of
rouble unless the mass has been displaced

and pressed down upon the drum-head, although even then it may be moulded to a perfect cast of the tympanic membrane-surface without genuine pain, which must therefore usually be taken as an indication of inflammatory involvement calling all the more urgently for prompt and gentle removal.

Tradition is responsible for the habit of dropping oil or other fluids into the ear as a preliminary "to soften the wax;" but this rather tends to swell the mass and increase pressure without any compensating advantage in facilitating its removal, while it is utterly reprehensible as a supposed substitute. Careful, vigorous syringing with hot water (105°-115° F.) is the proper procedure for removing the wax; no better solvent than hot water is obtainable. Yet syringing, like most manipulations of the ear, may cause dizziness, or even fainting; and should be discontinued and the patient laid flat on the back at the first symptoms of such an occurrence. Ear-scoops or mops are permissible only in the hands of a skilled aurist, and he will use them but little. An ear that has been syringed and freed from obstructive material should generally be dried as thoroughly as possible and protected from air for the rest of the day by a flake of cotton. On the other hand, any habit of wearing cotton is to be condemned as useless, uncleanly, and prone to interfere with the proper exit of wax. Often a forgotten plug is the basis of a wax collection obstructing the canal.

Foreign Bodies in the Ear.—The months or years that such masses may remain unnoticed, or at least without irritation, in the ear exemplifies the slight harm that may arise from insects, pebbles, or other objects entering the canal. A living insect must be smothered with oil, vapor of chloroform (which can be poured like a fluid from a drop in the bowl of a spoon), or even water, lest its movements cause unbearable distress; but any dead, inactive object is generally devoid of irritating effect. Children rarely introduce beads or such objects deeper than the soft portion of the canal, from which they will easily fall out if the head be inclined to the side and the canal straightened by pulling the auricle outward and backward. But great danger to life as well as to hearing may be caused by injudicious and panicky efforts to extract these intruders. Most of the cases that come to the physician have been seriously complicated by meddling; and if he makes good use of syringing without obtaining an early success and advises delay, another and more active operator is likely to be sought. Too often some form of forceps is introduced into the canal in hope of withdrawing the foreign body, and it is pressed deeper and wedged in the bony canal or actually driven through the drum-head into the tympanic cavity. At times, like damage is done when no foreign body is present—the wrong ear being worked at or the object having already fallen out unnoticed. No examination or operation should be undertaken without good illumination; and it sometimes suffices to let the light fall in past the examiner's brow while the canal is straightened by pulling the ear upward, backward, and outward, in order to give a good view. It should be clearly and positively borne in mind that foreign bodies seldom cause serious harm, even if remaining for years, unless they furnish an excuse for harmful interference, and we may look for few of the bad results that have been disgracefully frequent in the past. Rotary rubbing in front of the ear while it is turned downward will permit many a small body to fall out promptly. Any other measures besides this and careful syringing should be entrusted only to the expert; for when the foreign body is really wedged fast, it is at times a safer and simpler measure to remove it by cutting the soft parts loose and turning them out of the way, than to probe blindly in a narrow, swollen canal in which terrible damage may easily be done unseen.

Slight itching and irritation of the canal are very common, and may occur with or without distinct eczema, perhaps of gouty origin. They are important as giving occasion to the thrusting of objects into the ear to scratch it, or to the dropping in of oil or other fluids. Such measures are likely to aggravate the condition; and any break of the surface is easily infected, and causes a boil or perhaps a long series of such abscesses. These may be terribly painful and exhausting, but are rarely serious to life or hearing; yet they are easily confounded with the serious conditions of pus in the middle ear and may cause needless alarm. Douching with pure water as hot as can be borne may assuage and perhaps quickly terminate those already present; but skilful care is needed to cut short the rather probable series of such boils, as gland after gland becomes affected. Deep extension of the inflammation may involve the periosteum covering the bony wall, and not only may the swelling press forward the auricle and simulate an abscess of the mastoid, but the nutrition of the bone may be injured and its decay ensue, possibly with penetration of the process into the deep structures. Such an infection, although "only a boil," is not to be lightly regarded.

Whether the presence of invisible germs is the cause or only a consequence of such affections, long experience has shown the high value of remedies inimical to such life; and we note at times as the result of improper conditions a growth of mould inside the ear. The diffused inflammation, with its heat and moisture, is probably first present to furnish a favorable site for such growths; but they certainly tend to keep up such a condition by their presence. The precise aspergillus or penicillium present is rather a botanical than a hygienic matter; although the occupation and surroundings of patients doubtless have influence in making them liable to such implanting of one or another form. The growths do not occur in healthy ears, and will disappear as soon as dryness and more normal conditions have been secured. Dropping of oil or other fluids into the ear may not have been so distinctly responsible for such growths as some claim, but it is surely not the best way to combat such conditions when present.

Overgrowth of the bony wall of the canal is a curious condition—fortunately rare—and one or more of the bony knobs may encroach on the passageway. These may be broad-based and ill-defined, or form tumors with narrow, stalk-like attachments; hence their division into hyperostoses and exostoses respectively. Often there is a discharge from the middle ear, which affords by its irritation of the surface some explanation of the growth and greatly enhances its seriousness. There is little likelihood that such a bony mass will close the canal so that sound-waves cannot enter; but it may readily interfere with due exit of discharge and lead to the most serious consequences. In many of the cases the cause is quite doubtful, but the fact that it is far more common in the upper-class Englishmen than in any other people (unless the semi-amphibious Sandwich Islanders) points to bathing as a rather likely factor in its production.

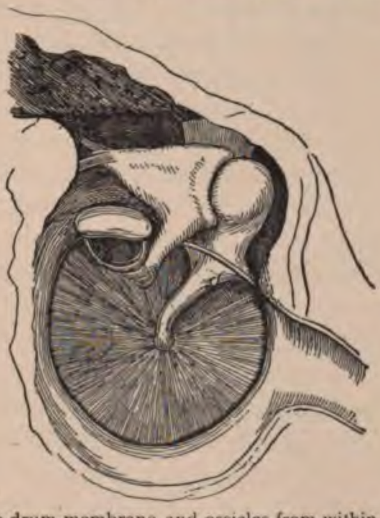

FIG. 33.—The drum-membrane and ossicles from within, showing attachment of malleus-handle to drum-head, the insertion of the tensor tendon below the chorda, the axis of rotation through the gracilis process and the posterior ligament of the incus, and the tooth of its articulation with the malleus head.

The Drum-membrane.—At the bottom of the external canal is stretched a thin, tense membrane—the tympanic membrane, or the drum-head (Fig. 33)—

which separates the external from the middle ear. It is very oblique in position; its lower margin is farther from the outside than its upper, and the forward is deeper than the back part—so it could be called quite accurately the lower rather than the outer wall of the drum-cavity. The outer layer of the drum-head is continuous with the skin-lining of the canal and really belongs to it clinically; but in most respects it is considered with the middle ear, which it bounds. Its function is largely protective, although it also serves as a receiver for sound-waves and aids in conveying them to the internal ear through the chain of little ear-bones (ossicles) connected with it; but an opening in it, or even its total loss, may hardly impair the hearing to a recognizable degree. Low tones will perhaps be heard less distinctly, but high tones rather better for its absence. The old impression that hearing depends upon the drum-head is exploded; yet its removal, even when it has become an obstacle to hearing, has not often proved a judicious measure. The eyelids are not essential to perfect sight, yet they are very important to its safety; just so the drum-head shuts out many hurtful influences and helps to maintain a moist, pliable condition of the important parts within it. The handle of the tiny hammer-bone (malleus) is encased in the upper part of the drum-head and reaches down to its middle. The membrane is kept stretched tightly inward, and the shallow funnel shape thus given adapts it to respond to a very wide range of vibrations. The slight thickening due to age causes it to vibrate less perfectly and to impede the penetration of high-pitched sound-waves; and disease-changes may act similarly and much worse at any period of life.

The drum-head may be torn by the penetration of twigs, hair-pins, toothpicks, etc., stuck into the ear; or it may be split by explosions or a severe box on the ear. Deafness may be extreme after such accidents, but it is the result of the concussion of the recipient apparatus beyond the drum-head, and it may persist after prompt and perfect healing of any rents. Most patients with discharge from the ear have an opening in the drum-head, yet may have practically unaffected hearing, and such "holes in the drum" are by no means the death-warrant of the function whether the perforation closes or not. Loss or change of the drum-head may give occasion for the employment of an "**artificial ear-drum**;" but, as a rule, only for its effect in tightening relaxed portions of the conducting-apparatus. Such an apparatus has its parallel in the bridge of a violin rather than in the head of a drum. Most of the much lauded patent "ear-drums" are inferior to a little pellet of cotton, which is so placed that its pressure will tune up the mechanism without too much irritation. However, all artificial ear-drums generally irritate, and after short use are advantageously discarded with retention of any gain in hearing. Most of the advertisements in conflict with this statement are false and misleading. As the proportion is small of cases of deafness in which such laxness of tissue is at fault, the field of usefulness of artificial ear-drums is very narrow; and, like any other foreign body thrust in the ear, they may cause much irritation or damage even in cases needing them.

Injuries to the Drum-membrane.—Some of the less sharp but rather more persistent earaches are of merely mechanical origin and due to preponderance of atmospheric pressure on the outside of the drum-head when there is lowered pressure within. They are comparable to that due to diving into deep water or entering the compressed air of a caisson. In the latter case swallowing, or yawning, or Valsalva inflation equalizes the pressure (as can hardly be done by the diver), and precautions of this sort must be carefully taken in the air-lock on both entering and leaving the caisson. The healthy ear-drum can bear a pressure on either surface of some fifteen pounds to the square inch, but more than this will probably rupture it, while much less may give severe pain and cause inflammation. When weakened by disease, small pressure may rupture the membrane, and not only explosions, but a box or other tap on the ear may have such a result. So too even the slight suction of a kiss on the ear has been credited with rupturing the drum-head, and to almost all persons such a demonstration is very painful. It is also possible that inflation by the Valsalva or Politzer method may burst the drum-head from within; and violent coughing, as in whooping-cough, often causes breaking of small blood-vessels or even tearing of the tympanic membrane. Such shocks as are experienced in violent falls may rupture the drum-head. This is frequent in fractures of the base of the skull, and the flow of blood from the ear is often taken as proving a serious and probably fatal injury; yet the tear may be independent of fracture, and may be from the wall of the canal without severe injury to the bone. In rare cases a fall upon the chin may drive the lower jaw back into the ear-canal and cause any of the previous symptoms. Non-interference and mere protection should be the rule in all such injuries. Syringing and instillations are usually uncalled for, and are likely to do harm, and the expert aurist intervenes only for clear cause. Such a rupture of the drum-head will usually heal after a time, even though it shows no early promise of such repair, and the aurist has at command means to secure this when it would otherwise be doubtful.

Disease of the Drum-membrane.—Most of the ruptures of the drum-head are due to the outbreak of fluid from within; and while some of these are mere pressings aside of the fibers, which close again without scar, others take place only after so much ulcerative destruction that a considerable perforation is made or the whole membrane may be destroyed. Healing after the loss of tissue entails new scar-tissue, which is generally recognizable by its thinness and is likely to stretch and sag out of the plane of the rest of the drum-head. As has been said, it was formerly thought that the drum-head was very essential to hearing, and that perforations in it never healed, but entailed permanent defect or loss of hearing. On the contrary, we now know that it may be destroyed by disease or removed by the surgeon with little impairment of the hearing, and that large openings may close nicely even after they have been present for years. The cutting away of the entire drum-membrane is followed by its renewal in many cases, and without its destruction we sometimes find a membrane not unlike the drum-head formed across the canal external to the real membrane. The protective function of the membrane is very important, and we usually desire its repair in every case even although it may prove rather an impediment than an aid to hearing. Many operations have been done to remove it wholly or in part when its changes make it an obstacle to the access of sound-waves; but these have generally failed because of its regrowth, or when successful in securing a permanent opening they have been followed in a year or two by a loss of all the gain in hearing and generally of what was before possessed. Such operations have, therefore, been generally abandoned. When the drum-head is open the cavity within is likely to become too dry for the best hearing, while it is constantly liable to irritation from the entrance of water or dust, with lighting-up of severe inflammation. All of these inflammations have danger, for extension may easily take place to adjacent important structures, and fatal meningitis, brain-abscess, or general blood-poisoning may ensue.

One of the curious and pernicious conditions frequently met is a tendency to grafting of skin-flakes from the outside of the drum-head upon the succulent lining of the middle-ear cavities. Here their extraordinary power of growth is increased by unusual food-supply, and the cavity becomes lined with skin, which sheds rapidly, layer upon layer, until onion-like masses of **cholesteatoma** are formed. These may provoke suppuration as an effort of nature to soften and break them down, and by pressure they cause absorption or destruction of the bony surroundings, opening a way for escape—outward, perhaps, but too often inward upon the brain. Many, if not most, cases of persistent or recurrent ear-discharges are complicated and probably caused by such cholesteatomatous collections.

THE MIDDLE EAR.

The middle ear, which lies beyond the drum-head, is the seat of two-thirds of all aural troubles, and as some of its affections are of the utmost danger to life as well as to hearing, its health is proportionally still more important. It is by no means so limited in extent as often considered, for the drum-head forms the lower, outer wall of only one portion of the drum-cavity; while the Eustachian tube, extending forward an inch or more to connect it with the upper part of the throat, and the air-cells, which extend backward into the mastoid region (and may also penetrate every portion of the temporal bone), are equally portions of the middle ear. It is a part of the upper air-passages, very complex, and not easily affected throughout by their diseases, but as likely to be involved as any of the accessory cavities of the nose; while the intricacy of the field or the extreme delicacy of some portions makes persistence of the trouble very probable. Hence it has been calculated that at least one-third of all our adult population are notably deaf in one or both ears. The census informs us that no less than 700 per million are dumb as the result of deafness, but these represent only a small group who lost their hearing before they had fully acquired speech.

The middle ear is an intricate air-space developed outward from that portion of the air-passages where nose and throat meet. At this point is the trumpet-mouth of the **Eustachian tube** (Fig. 34)—above the soft palate, but in close relation to the tonsil-masses on each side of the back of the mouth and to the more important tonsil in the vault above the palate. On account of the influence of nasal disease on the ear much of the real hygiene of the ear is considered in the preceding chapter. The whole middle ear is lined with mucous membrane absolutely continuous with that in the nose and throat, and, like it, having its effete cells melt down into sticky mucus instead of shedding off as scales. Much of the epithelium is furnished with cilia to sweep this fluid on into the throat, so the Eustachian tube is very important as a drainage-canal; but its ventilating function should receive equal consideration. This drum-head, like the martial instrument, must have a side opening

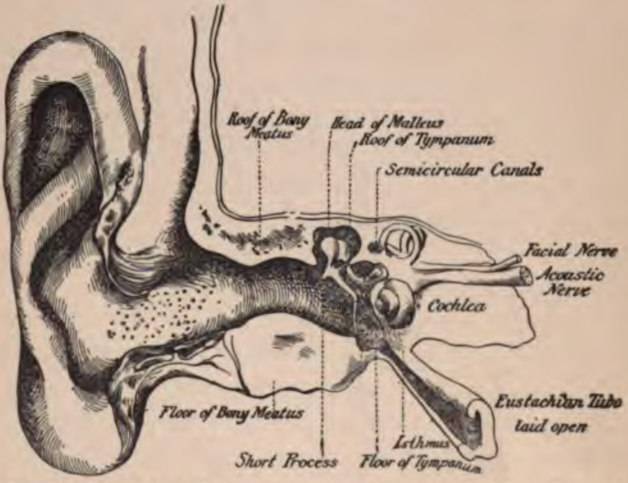

FIG. 34.—Frontal section of the organ of hearing (modified from Politzer).

through which air-pressure may be maintained equal on both sides of the drum-head if it is rightly to perform its part. If this aperture is closed, not only will the sounds unnaturally reverberate within, but the air will be absorbed by the moist walls and the partial vacuum will affect the ill-supported drum-membrane and other structures. Preponderating outside pressure will force in the drum-head, rendering it unduly tense or stretching it out of shape. The stapes at the end of the chain of ossicles will be pressed too much upon the labyrinth, causing deafness, dizziness, and subjective noises; and there will be a tendency to undue congestion and oversecretion in response to the lessened air-pressure. Normally every act of swallowing, yawning, etc., opens the tubes and gives a chance for equalization of intratympanic pressure, for the palate-muscles act as dilators of the tube; but a stopped-up nose reverses the process and then, if the tubes are not likewise stopped, every swallowing motion draws air out of the ears.

In the foregoing we face at once the **causes of most cases of deafness,** and it is probable that hereditary influence, such as is often cited, lies really in an inherited configuration of the nose, or a tendency to catarrhal affections of its mucous membranes. Every "cold-in-the-head" tends in one of the ways above mentioned mechanically to involve the ears, even if no continuation of the process actually invades the tympanic cavity; and while the recovery may seem complete, there is likely to be some unrelieved remnant of trouble insidiously but steadily increasing, and first one ear and then the other shows the decrease in hearing. The deafness may be quite marked at the onset if the involvement is considerable, and may be far from totally relieved, although greatly better as the attack passes off; yet if only one ear is impaired the condition may progress extensively before the patient is ready to believe that anything is really wrong. It was computed by von Troeltsch that one-third of all adults are deaf to considerable degree in one or both ears; and all later students accept this as a fair estimate. Examinations in the schools show only a less degree of trouble but a most threatening array of beginning cases, with disability of one ear in 10 per cent. and of both ears in 5 per cent. even of young children.

The aspect grows much more serious when we consider the inflammatory involvements which often accompany the eruptive diseases, especially scarlet fever and measles, but also typhoid fever and smallpox, and probably in the worst form in diphtheria. In such cases the physician is usually in attendance, and may be driven to vigorous action; yet too often the gravity of the general condition leads to overlooking or underrating the ear-affection, and irremediable conditions develop that certainly ought to have been foreseen and combated. It may be unfair to ascribe bad results solely to neglect, since the best treatment is not always of avail; but it is surely injudicious to leave untried the simple measures which may save the hearing, or even the life, on the assumption that the patient is too sick to be thus troubled.

The suppurative diseases of the tympanic cavities call for much more than hygiene, but this has a place in reducing the probabilities of serious outcome and in making the condition less offensive to neighbors. Cleansing is the first and sometimes the only requisite in abating or curing these conditions, and should be most faithfully carried out, under medical direction if possible. Odor, sometimes such as to make the sufferer intolerable to those about him, is not an infrequent penalty of incomplete cleanliness; and while full success may be possible even to the expert only after operative laying open of the cavities to secure better access, mitigation can generally be secured in the worst cases. Life-insurance companies generally refuse to insure those with discharging ears, knowing that the risk is a very real one, and that serious results may at any time follow a slight or unrecognizable cause. The often-cited prediction that such affections will "be outgrown" if let alone, and the falser claim that it is dangerous to check such discharges, have now few medical supporters, and the danger of blocking the flow is becoming recognized as utterly different from the policy of lessening or terminating its formation. People are learning that when an otorrhea stops spontaneously—as when the rash in measles or scarlatina "strikes in"—it is the result and not the cause of serious trouble lighting up in deeper structures.

Decay of the bony structures of the ear is very prone to render obstinate and protracted the other features of the case, but modern aural surgery has taught physicians to cut promptly and with fair safety many a knot that until recently was beyond disentangling.

General ill-health is a most serious factor in maintaining these rebellious affections; but they are, on the other hand, frequent causes of debility or general disease. Not a few of the ear-inflammations of early life are tubercular in their nature, and may give rise to infected neck-glands first and to consumption of the lungs or other organs later. Too conservative a success in securing absorption of such deposits may later prove in reality the most disastrous of failures. The ear-symptoms of these attacks are not always well marked, and the case may resemble one of typhoid fever or meningitis, in the course of which the appearance of an ear-discharge will be unnoted or ignored. It is the physician's duty to search for aural disease in all doubtful cases without waiting for it to force itself upon the attention, and as soon as recognized to treat it vigorously even if there is little likelihood of a dangerous result. Until this care is commonly observed there will be far too many deaths and disablements ascribed to meningitis of unknown origin.

Earache.—More within the scope of this work are the cases of ear-inflammation arising from "cold," and generally known as "earaches." The common assumption that they are mere neuralgias is upset in nearly every case carefully examined. The affected drum-head is visibly congested, often distended by the secretions within, and pressure in front of the ear almost always reveals tenderness which is fairly characteristic. The dropping in of sweet oil and laudanum will probably be continued in spite of all that shall ever be written or said against it, and roasted onions and hosts of similar substances will be employed to the end of time. "**Ear-drops**" in countless variety have been commended as infallible, and the last one employed before relief (perhaps in spite of it) gets the credit of a cure. Not only is all of this unscientific, but it is very irrational. Examination alone can determine the form and grade of the affection. It is sometimes a mere boil of the canal, due in part to scratching or other accidental infection, with no danger beyond the temporary pain and stoppage or perhaps recurrence of the infection.

More often the pain is due to a serous catarrh of the tympanum, and will yield only with the outbreak through the drum-head of the pent-up secretion. Few children escape attacks of this sort, and the evidence remains in a minute perforation or scars in so large a number that some anatomists have believed this to be a normal feature of the upper margin of the drum-head. Yet such a condition is practically unknown in infancy, is found increasingly frequent throughout childhood, and is present in 25 per cent. of all adult drum-heads, excluding the cases in which there was recognized discharge. There may have been no discharge or "running at the ear." One or two drops of pus which were forced through the drum-head may not have reached the outside or may have mixed unrecognized with the fluids dropped into the ear; or the sudden relief which commonly marks these cases may have been gained by opening of the Eustachian tube, allowing exit in that direction. Sometimes the brunt of the affection has fallen upon the drum-head alone, and small blisters or pustules on its surface have caused brief suffering with little deafness or danger. Cold air or cold water entering the canal may be responsible for such a condition; but usually these act through the Eustachian tube, and the condition is truly middle-ear inflammation. Few of the patients getting "water in the ear," especially when knocked about by a breaker, would have been helped by plugging the outside ear. It has been water in the nose acting upon or through the Eustachian tube which has wrought the mischief, the choking or nose-blowing having helped to carry the fluid where it could irritate. Any liquid in the drum-cavity has usually formed there as a serous exudation, for it is very hard even intentionally to carry fluid all the way up from the nasopharynx. Any one who blows the nose after spraying it or otherwise introducing fluid can hear the bubbling in the tube-mouth, and can realize the importance of draining away all such fluid before blowing. Carelessness as to this or in using too much pressure has brought "**the dangerous nasal douche**" into disrepute among all aurists, and made them view with suspicion many other methods of washing the nasal cavities. If employing watery fluids otherwise than in spray, only the narrower side of a fairly free nose should receive the fluid, which is allowed to escape from the wider side. The pressure should be but slight, and when the gravity douche is used the level of its fluid should not be above the brow. There must be as complete draining away of the fluid as possible before blowing the nose.

In all cases of the exanthematous diseases in which the ears are usually in peril, as well as in all that show earache, protection counts for much in warding off evil; and the old-fashioned **night-cap** may be worn with great advantage. A mere flake or plug of cotton in the ear is as likely to do harm as good, for it is rather the ear-region than the canal alone that needs protection in bed. One side of the head is for a while buried in the pillow and perhaps rather macerated by perspiration, and is then turned up unprotected to the cool air and evaporation, with a probable reduction of 40° in temperature in a few minutes. It is small wonder that an ear that has struggled against inflammatory influences during the day will light up to acute pain an hour or two after bed-time, as is the usual history of these cases. The night-cap may then give little relief, but is potent to forestall such attacks on subsequent nights. The relief of such earaches properly belongs to medicine rather than to hygiene, but it should be better known generally that **heat** is the most valuable single remedy. Most of the "ear-drops" merely serve as means of conveying heat to the inflamed parts, and pure water can do this better than any other means. It is usually difficult to persuade people that a remedy so universally at hand as hot water is to be preferred to the host of less available and less harmless "cures;" yet one has but to try the **hot-water bottle** externally, and **gentle douching** or simple pouring of hot water into the upturned ear, to find how grateful it generally proves. Severe inflammations are not cured at once by this or any other means. Vigorous leeching in the early stages is commonly held to be even more efficacious if available; but hot douching tends to relieve pain by reducing the inflammation, and it is safe at all stages and serves to cleanse the canal of any undesirable material, such as wax, skin-flakes, or microbes. It must, of course, be free from contamination itself. Boiled water, chilled to a bearable heat and used with a well-scalded syringe or other means, will probably never do the slightest harm. The ear should be dried as well as possible after its use, as well as protected from external influences, the covering being reinforced by cotton or wool as required. Bodily activity or general temperature-changes may greatly aggravate the pain, so rest, especially in bed, with light diet is to be strongly urged. Soft food is usually requisite, since every chewing effort gives pain; and constipation or any other cause of head-congestion should be relieved if possible. Each case of this kind must be treated as the amenable initial stage of what may prove a serious or even fatal malady, and no pains should be spared to relieve it.

THE INTERNAL EAR.

In some cases of middle-ear involvement there occurs, early or late, an implication of the internal ear. This may be a direct extension of the inflammatory process with rapid destruction, or it may follow upon incapacitation of the conductive apparatus and atrophy through disuse of the percipient apparatus beyond. In certain constitutional diseases an overwhelming dose of the poison may fall upon the nerves of hearing without other symptoms of ear-involvement. Mumps, more rarely diphtheria, but most often syphilis, inherited or acquired, may produce marked or total deafness; and meningitis of the epidemic or other types would often leave deafness if so many of its victims did not succumb. In many of these cases tonic medication promoting the absorption of inflammatory products may rescue the hearing more or less completely; and in every case in which there is reason to suspect, from the stigmata of syphilis or from the mere absence of local disease, that the nervous apparatus is at fault, such medication should be given full trial.

The term "**nerve-deafness**" was once a cloak for ignorance as to conditions readily shown to be of a different nature; but this trouble is now receiving due recognition as a real and most important matter.

There are affections of other nerves than that of hearing connected with ear-disease. The facial nerve, which controls the motion of most of the face-muscles, accompanies the auditory nerve into the ear and passes on through its substance to emerge near the angle of the jaw. It is much exposed to involvement in ear-inflammations, although the latter may prove so evanescent as to leave little trace by the time the **facial palsy** becomes well developed.

"Noises in the Ear" (Tinnitus Aurium).—Quite as trying to many persons as all the inconveniences of deafness are the "noises in the head" which often accompany it. These may be of every character—roaring, hissing, ringing, thumping—and many of them may seem unbearable, especially if constantly present. The noises have no definite relation to defect of hearing, and may persist for decades without deafness or be wholly absent while the hearing is distinctly failing. However, they are often enough associated with deafness to make them commonly dreaded as foreshadowing and intensifying that calamity. When we add that they sometimes defy all efforts to quiet them and may even seem to keep the patient awake, it is small wonder that they have been often assigned as an excuse for suicide. Their causation is as varied as their character. They are generally the expression of irritation by pressure upon the nerve-endings in the labyrinth of the ear; but blood-changes are often responsible, and anemia may be the cause as well as plethora. While disturbed conditions of the conducting-apparatus are responsible for many cases, others are due to intracranial irritation, perhaps without the slightest ear-trouble. In a small but notable group of cases the real seat of the irritation is in the nose, and minute examination shows one or more areas of firm contact of parts which ought to be well separated. Well-directed treatment—shrinking, moving, or removing the tissues concerned—will produce prompt and perhaps permanent relief. In certain other cases the general vascular condition, and especially overaction of the heart, is the main cause of the trouble and must be medically treated. In rare instances there is a local dilatation of an artery, an aneurysm, giving rise to a noise which physician as well as patient can hear, and which pressure on the artery lower down will still. Another form of noise which bystanders can hear is a clicking due to opening of the Eustachian tube when the soft palate is lifted. This may be very distressing when there is spasmodic movement of this sort and calls for active tonic measures.

Tests for Hearing.—Much interest and importance center about the tests of hearing and the recognition, estimation, and localization of its defects. Much of the matter is outside of the strictly hygienic field, but certain broad facts deserve better comprehension. The ears should recognize sounds through some ten octaves; so, to be thorough, testing must have wide scope. The watch, often used as a test, has an impure, high sound of little practical value, since it may be well heard by very deaf ears or poorly by those perfect for all other tones. The voice is far more practical, since it has a wide range of pitch—perhaps from 100 to 5000 vibrations per second—and can be used in very varying volume. A faint whisper should be audible for ½ meter (20 inches) in a quiet place, and only by the ear directed toward the speaker; a stage whisper with the air remaining after an ordinary "tidal expiration" should be heard 15 meters (49 feet); while the need of a loud voice, if not very definite, still serves to mark extreme deafness. Tuning-forks of various pitch are good quantitative tests, and they enable us to compare the hearing through air and through the bones of the head, and thus to learn the seat of the trouble. In affections of the conducting-apparatus hearing for low tones is likely to be first impaired or lost, while it is the upper scale that usually suffers in nerve-deafness. So, too, a fork may be heard unduly loud and long when resting on the head, although ill-heard in the air before an ear with impaired conducting-apparatus; but with nerve-impairment the bone-conduction suffers more than the conduction through air. Hence a vibrating tuning-fork touching the head in the middle line ought to be heard louder in the deafer ear if the trouble is in the middle or the external ear; but worse in the deafer ear if the nerve-apparatus is at fault. Rested on the bridge of the nose, the ears should hear the vibrating fork as long as the fingers holding its handle feel the vibrations; but the duration is measurably less when the nerves are affected, and greater when impairment of the conducting parts shuts in the sound, just as it shuts out air-vibrations. Thus by a series of tests we are usually able to decide the amount and location of the defect of hearing and can take due measures for its relief. It need hardly be argued that deafness due to a plug of wax closing the canal, or to fluid poured out in the middle ear, or to a forcing in of the drum-head by preponderating outside pressure will not be relieved by the same measures as should be employed in cases of paralysis of the auditory nerve by the poison of syphilis or the pressure of a blood-clot or tumor.

Ear-Trumpets.—A word should be said as to aids for the deaf. These are offered in countless forms and with shameless advocacy. Many of them have good points for the few cases for which they are suited : none have half the value or field of usefulness claimed by their inventors. There have been mentioned already the use and limitations of "ear-drums." Ear-trumpets are valuable usually in direct proportion to their size, since they aid solely by concentrating a greater volume of sound-waves, and inconspicuous aids are usually of little value. When the hearing through the bone is much better than through the air, fan-like instruments held to the teeth may prove real helps. Of a dozen of the same make one or two trumpets may be far better than the rest, and the deaf person should obtain advice as to the kind of instrument to test and then try a number of that form. Such aids are not only of temporary benefit, but when rightly used they may permanently improve the hearing.

THE HYGIENE OF THE EYE.

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GENERAL DESCRIPTION OF THE EYEBALL AND ITS DISEASES.

Advantages of Binocular Vision.—Fortunately man is endowed with two eyeballs. Such a delicate organ as the eye is very susceptible to destruction of function from injury and disease, and in case one eye is ruined its fellow can in great part compensate for the loss. The additional advantages of binocular vision are many. There is a more accurate estimation of size, depth, distance, direction, and motion, all of which are matters of gradual education from infancy and have psychologic and physiologic explanations which are not within the province of this article. Binocular vision also affords a much better field. A person with one eye is handicapped by the limitations of vision caused by the protrusion of the nose obscuring objects on the side of the blind eye.

The eyeball resembles in shape a sphere or globe; on the anterior surface of which is placed the segment of a smaller sphere (Fig. 35). The average diameter of the eyeball is approximately one inch. It is a trifle longer anteroposteriorly than vertically. It is contained in a conical cavity formed by the bones of the face and skull, called the **orbit** (Fig. 36), and is supported by a cushion of fat and other tissues. It is held in place by its membranes and muscles, by which it is also moved; and it is surrounded by a thin membranous sac, called the **capsule of Tenon.** Hence, laterally and posteriorly the eye-

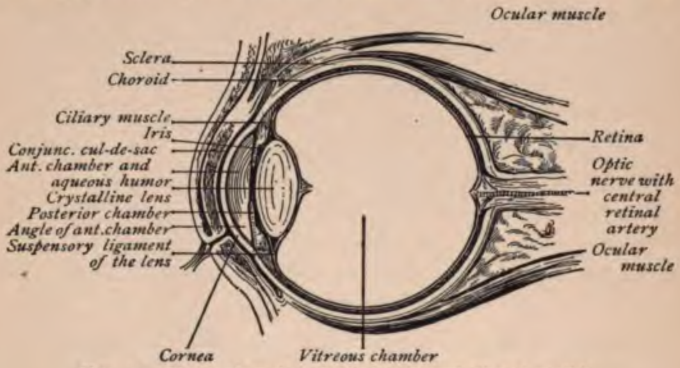

FIG. 35.—Vertical section through the eyeball and eyelids.

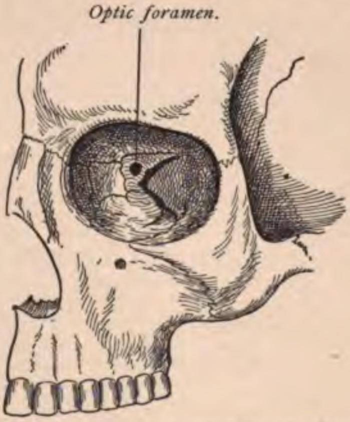

FIG. 36.—The bony orbit, showing the optic foramen.

ball is well protected by the bony orbit, and is shielded against shock by the orbital tissue and fat. So important is the function of the fat of the orbit that it is said to be the last to disappear in emaciation from disease or starvation.

The anatomic conformation of the skull varies greatly in different individuals and race; and according as the orbit is deeply set with overhanging ridges of the frontal bone, or is more exposed, there is a different amount of bony protection afforded the eyeball. Some eyes are very deep set in the skull, while others are quite protruding and more liable to injury. Anteriorly the eyeball is protected by the eyebrows, eyelids, and eyelashes.

The eyebrows are formed of muscle, thickened skin, and stiff hairs, which rest over a bony ridge in the front of the skull above the margin of the orbit. They are not seen in the lower animals. The functions of the eyebrows are to protect the eye from dust and perspiration, and to give shade to the eye. The eyebrows have a marked influence on facial expression, and many shades of emotion are portrayed by their movements. In some persons the eyebrows are very scant, in fact in fair women they are sometimes only delicately pencilled, while in others, for instance swarthy men, they are long, thick, and bushy, giving a most ferocious appearance, especially when unkempt. There is a tendency for the hair of the eyebrows to become thickened and tough in advancing age. Burns of the eyebrow require the same treatment as skin-burns, and unless the damage has been very severe the hairs will reappear. Dropping out of the hairs of the eyebrows and other defects may be treated in the same manner as hair-defects elsewhere.

The eyelids are composed of thin, loose skin, elastic tissue, delicate muscle, and plates of cartilage, called the tarsal cartilages, which give the lids shape and firmness. The upper lid is the larger and is movable, while the lower lid is almost stationary. There is no fat in the eyelids, and if this were not the case, in extreme obesity they would become closed by their weight. However, the loose tissue of the lids affords an ideal field for swelling, and after blows or in inflammatory conditions, such as erysipelas, we find the lids sometimes so swollen as to be entirely closed.

The ordinary "**black eye**" is simply extravasation of blood into the loose tissues of the lid, from which it is some little time in being absorbed. In recent injury or disease of the lids, cold in the form of iced compresses is indicated to prevent further exudation, while in the later stages hot compresses are necessary to promote absorption of the exudation or hemorrhage which has already taken place. There is no virtue in a poultice beyond the continued heat, and local medicinal measures are of little value. For cosmetic purposes a bruised lid may be painted flesh color.

The delicate construction of the eyelid enables the physician to judge well of the general circulation from its appearance. A dark hue of the skin of the lids, the so-called "rings around the eyes," is indicative of a sluggish circulation or of changes in the composition of the blood. Puffiness or swelling of the lids, popularly known as "bags under the eyes," is often an early sign of disease of the heart or kidney.

The lids are lined with a very smooth membrane, called the conjunctiva, which will be spoken of later. They are maintained in close apposition to the eyeball by atmospheric pressure. They move freely and without friction on account of the smoothness of their inner surfaces and the outer surface of the eyeball, and the lubrication by the tears and the mucus secreted by the conjunctiva. On the edges of the lids, near the roots of the lashes, are the small **Meibomian glands,** which secrete an oily substance greasing the lid-borders and helping to prevent the overflow of tears.

An important function of the lids is to distribute the tears over the front of the eyeball, and by incessant winking to free the front of the eye from dust and keep it moist. The winking also acts as a hydraulic pump in discharging the excess of tears through the tear-duct into the nose, besides affording frequent intervals of rest for the retina. When the eyelids are paralyzed or when on account of protrusion of the eyeball they cannot be closed, the front of the eyeball, or cornea, quickly loses its lustre and transparency, and unless this is speedily remedied blindness will ensue.

The protective function of the eyelids is very evident, and is so automatic that the lids close reflexly at the approach of a foreign body or a threatened blow.

The opening between the lids is called the **commissure,** and on the width and breadth of this depends the size of the eye. When one speaks of a large eye or a small eye, reference is made to the size of the palpebral commissure and not to the size of the eyeball. There is no noticeable difference in the actual size of healthy eyeballs, except, of course, as belongs to the different ages, the child having a smaller eyeball than the adult. However, in some persons the size of the pupil gives to the eye an additional element of size. The racial characteristics are transmitted in the size and shape of the commissure, as is shown in the almond eye of the Mongolian. The shape of the commissure has a marked influence upon the expression and upon the personal beauty. Actresses avail themselves of dextrous pencilling to prolong the shadow of the commissure and produce impression of large eyes. A villainous expression is made by pencilling the outer angles of the commissure upward. A drooping and partially closed lid gives the impression of languor, and it is also used by artists to portray fatigue and voluptuous passion. In the final stages of wasting diseases the half-closed eye is a sign of impending physical dissolution.

The eyelashes, or cilia, are given off from the lid-border, and differ from the hair elsewhere by their finer texture and in being thicker in the middle than at the ends. They are arranged in two curves, those of the upper lid having their convexity downward while those of the lower lid have their convexity upward. Thus when the lids are partially closed, the eyelashes interlace, forming a screen against wind, dust, or excessive light, while still allowing the entrance of light and vision. They are supplied with sensitive nerves at their roots which serve to warn against the approach of small bodies when in the dark, or when the vision is intently employed elsewhere. The lashes are constantly being renewed but the falling out should not be noticeable.

In certain inflammatory conditions of the lid-border, known as **blepharitis,** the eyelashes may so fall out as to become very sparse. If the inflammation is allowed to go untreated, there is often formed a permanent "**blear eye;**" the new lashes come in stiff and are often misdirected, turning in toward the eyeball instead of outward. These wandering lashes are popularly known as "**wild hairs,**" and cause great discomfort by constantly rubbing against the sensitive cornea. Such errant cilia must be constantly pulled out, or their bulbs must be destroyed by electricity, and in some cases even a plastic operation on the lids is necessary for relief.

Inflammation of the lid-edges with destruction and distortion of the lashes is a most unsightly facial blemish, and if not properly treated will grow progressively worse. In a great number of cases it is one of the many results of ocular congestion from uncorrected eye-strain, and will only be relieved by the wearing of the proper glasses. Salves and ointments may alleviate, but will never cure such cases. In other instances blepharitis is a local expression of a general disease showing elsewhere in the skin, and will only yield to general medicinal and dietetic treatment in the hands of a competent physician. An exceptional cause is the presence of tiny insects, nits, pediculosis (lice), or scabies (itch), at the roots of the lashes. In some cases the vitality of the lashes is lowered in common with that of the hair elsewhere. In such cases a stimulating or irritant treatment is indicated.

The lacrimal or tear apparatus (Fig. 37) consists of a lacrimal gland which secretes the tears. It is situated at the upper and outer angle of the orbit, and is connected to the conjunctival cul-de-sac between the eyelids and the eyeball by eight to twelve small ducts which open by a series of pores about $\frac{1}{20}$ of an inch apart, at a little beyond the border of the upper lid. The tears are discharged from the gland into the conjunctival sac and flow across the front of the eyeball toward the inner corner of the eyelids, where they are received in a small opening in both upper and lower lid-borders, called the **punctum.** From here they flow through two minute canals, called the lacrimal **canaliculi,** to the **lacrimal sac,** or "**tear-bag,**" lodged in a groove in the lacrimal bone below the inner angle of the lid-commissure, or internal canthus. When distended, this sac forms a protrusion at the inner angle of the lids and may be compressed through the lower lid, expelling its contents through the punctum into the conjunctival cul-de-sac or into the nose. From the lacrimal sac the

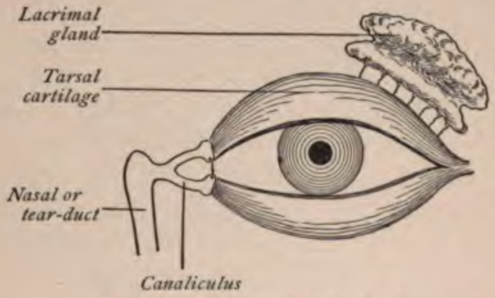

FIG. 37.—Diagram of the lacrimal apparatus.

tears are directed through a bony canal, ¾ inch long, called the **nasal duct,** into the nose.

The forces at work in the passages of the tears from the gland to the nose are capillary attraction, as furnished in the canals, gravity causing them to fall over the conjunctiva and through the canals, and muscular movement of the lids in winking. In the act of winking the tear-sac is expanded by traction of the muscles, and the tears are sucked into it; then passive contraction of the tense elastic sac expels the tears on through the nasal duct into the nose.

Ordinarily there is such a perfect balance between the secretion and excretion of tears that by no subjective sign are we conscious of them. When, however, from emotion or by irritation from the wind, dust, pungent vapors, or intense light there is an excessive secretion of the tears they may overflow the lids and roll down the face as well as be felt in the nose. In crying or on a windy day there is usually an accompanying "sniffling" or "blowing of the nose," due to an increased amount of tears draining into the nasal chambers. Infants do not shed tears until after the third month.

Constant excessive lacrimation with overflow on the cheek, or **epiphora,** commonly called "tearing" or "watering of the eyes," may be due to: 1. Living in vapors or dust or chemicals, as millers, metal-grinders, excessive smokers, etc.; 2. Inflammation of the lid-membrane (conjunctivitis); 3. Eye-strain, either from excessive reading or working in bad light or from defective eyes. If a careful inquiry into the patient's habits and an examination of his inner lid-surfaces reveal no cause for the tearing, examination of the eyes under complete cycloplegia is advisable. When the tear-sac is distended and inflamed (**dacryocystitis**) very serious disturbance may result if the cause is not properly treated by a physician.

The conjunctiva is the thin, transparent mucous membrane that lines the front of the eyeball and is reflected to the inner surfaces of the eyelids, forming, when the lids are shut, a closed sac. Except over the cornea, the conjunctiva is quite vascular, and on account of its many small blood-vessels it is quite likely to become congested from irritation, injury, or disease, causing what is popularly known as "**pink eye**" or "**red eye.**" As an example, note the quickness of the eye to become red from the irritation of excessive tear-supply in weeping or following the irritating vapor of tobacco-smoke, or lodgement of a small foreign body.

The conjunctiva is continuous with the mucous membrane of the nose and mouth. Hence in inflammation of the nasal mucous membrane, as in an ordinary "cold in the head" or in influenza, the conjunctiva is quite likely to become much congested. In fact, in such cases people speak of "catching cold in the eyes." Again, in inflammation of the alimentary tract in chronic alcoholism or after a debauch it is common to see the "blood-shot eye."

True inflammation of the conjunctiva is called **conjunctivitis.** Ordinary catarrhal conjunctivitis, or "red eyes," is most commonly due to eye-strain, and until excessive eye-work is forbidden and the proper correcting lenses are ordered the conjunctivitis will continue to occur. Students who use their eyes excessively and often by poor light, firemen, puddlers, and others who are exposed to great glares or dazzling lights are subject to conjunctivitis. Other causes are chronic nasal catarrh, diseases of the tear-apparatus, working in irritating vapors, excessive smoking, particularly in a sitting position indoors, where clouds of smoke are constantly wreathed about the head and face. The roughened membrane gives rise to a continual sense of foreign body in the eye which causes the patient to rub and further irritate the membrane. The burning and smarting are sometimes intolerable. A pleasant eye-lotion in such cases is a 2 per cent. solution of boric acid in water.

Purulent conjunctivitis is fortunately a rare disease, as it speedily may become most fatal to the eye, causing the clear cornea to ulcerate, often destroying not only the sight, but also the whole eye. It is purulent conjunctivitis of new-born infants that is such a prolific cause of blindness. Immediately upon the appearance of red eyes in the first few days of life a physician should be summoned. A few hours' delay with home treatment may mean blindness for the child. The greatest care should be taken to prevent contagion in any household in which there is a purulent conjunctivitis. All towels, cloths, compresses, etc., used on the patient should be destroyed, and the soap and basins used should be kept separate, and if only one eye is infected every precaution should be taken to shield its fellow. One patient with purulent conjunctivitis has infected a whole family, several of the cases resulting most disastrously.

"**Granular lids**" is a name often given to ordinary chronic conjunctivitis by the laity. True granular lids, or **trachoma,** is a much more serious affection and is particularly obstinate. The inner conjunctival surface of the lids becomes roughened and by constantly irritating the cornea impairs its transparency. The inflammation also gives rise to distressing distortion of the lid-borders by the formation of contracting scar-tissue, which causes misdirection of the eyelashes, so that they turn in against the globe, a condition known as **entropion.** This disease is most common among the poorer classes, and particularly where many are huddled together in one dwelling and where dwellings are closely built. It is often almost epidemic in barracks and charitable institutions. When once an inmate of an almshouse, asylum, or school has been attacked by a severe case of conjunctivitis of any kind, he should be immediately reported to the physician and forbidden to use the public towels, soap, or wash-troughs, and should as far as possible be isolated from his fellows until his disease is cured. In the same way applicants for admission to large institutions or conscripts should have their eyes scrupulously examined, even to eversion of the upper lid, to be sure that there is no trachomatous disease present.

There is nearly always affection of the conjunctiva in measles—in fact, the "measly eye" is well known. Certain other infectious diseases, such as scarlet fever, small-pox, and diphtheria, may seriously affect the conjunctiva and cornea, even causing blindness. The nurse and medical attendant in their anxiety to preserve life should not neglect the necessary precautions to protect the eyes from serious invasion.

Subconjunctival hemorrhages are usually the result of a blow or other injury, but they sometimes occur spontaneously, and often in the night while asleep. While not always true, it may be said that this is indicative of brittle or degenerated blood-vessels, and that unless precautions are taken a cerebral apoplexy may follow. Hemorrhages of the conjuctiva sometimes occur in violent coughing or in straining at stool.

Many persons suffering more or less continuously from inflamed eyes are in the habit of treating themselves and paying no regard to the cause of the disease. They resort to the quack "eye-waters" or "eye-drops," many of which contain powerful drugs, such as cocain and atropin, the constant use of which only further augments the trouble.

A question often asked is, **whether hot or cold water is better for the eyes,** and even persons with healthy eyes continuälly bathe their eyes "to make them strong." In perfectly healthy eyes it is always unnecessary to use continuously any eye-wash or to open the eyes under water. The conjunctiva of man differs from that of a fish, and any prolonged exposure to water will surely cause irritation. In acute inflammations the application of cold water is soothing and retards inflammation; after the inflammation is well under way, continued applications of very hot water may help in constricting the blood-vessels, reducing swelling, and relieving pain. However, in cases of chronic conjunctivitis the patient is usually suffering from some unknown exciting cause continually operative, most likely eye-strain; and instead of attempting to treat himself or indifferently allowing the disease to progress, he should consult an oculist as to the advisability of wearing glasses or other treatment. If the habit of using eye-washes is firmly established, a very pleasant and harmless lotion is made by dissolving 40 grains of boric acid in 4 ounces of distilled water, rose-water, or camphor-water, and afterward filtering.

The proper way to use an eye-lotion is as follows: The patient should throw the head far back or recline in a chair or on a couch and look upward. The lower lid is gently pulled downward, and with a clean glass pipette or eye-dropper several drops of the solution are placed quickly but gently in the corner of the eye. The lids should not be violently closed, as in such case the liquid is all squeezed out on the cheek; but the eyeballs should be slowly rotated, diffusing the fluid over all parts of the conjunctival cul-de-sac. The lotion should be allowed to dry in the eye, and should not be wiped out with a handkerchief. The pipette should be cleansed before being used again. It is well to keep the lotion in a bottle with a sufficiently small neck to allow the glass pipette to act as a stopper in place of the ordinary cork. The use of **eye-cups** is not recommended.

Growths of the Conjunctiva.—Often fatty deposits in the conjunctiva cause needless alarm. A **pinguecula** is a small, yellowish growth on the conjunctiva over the eyeball, which, although often progressively increasing, never causes discomfort or needs treatment. A **pterygium** is a fleshy growth on the conjunctiva with the base toward either canthus and apex toward the pupil. This growth is common in old people, and especially in those who have been exposed for years in outdoor occupations, as, for instance, in sailors. It is not malignant, and if it enlarges so much as to interfere with the motion of the eyeball or to obscure vision it may be easily removed.

The cornea may be called the window of the eye. It is a transparent smooth tunic enclosing the anterior fifth of the eyeball. It is circular, and by the way it is fitted into the sclera it resembles a watch-crystal. It is without blood-vessels, but is supplied with an abundance of nerves, making it very sensitive. Disease of the cornea is very disastrous to vision, especially when the central portion over the pupil is affected, as it is quite likely to leave white scars which greatly interfere with vision. Unless formed in early childhood, these opacities are not likely to clear up. Diseases of the cornea are also very painful on account of the abundant nerve-supply, and the pain caused by exposure to light is great.

Corneal disease occurs particularly in persons who are run down in health, and in sickly or congenitally diseased children, who also show signs of ill-health elsewhere, such as bad teeth, nasal catarrh, etc. In such cases a rigorous tonic and dietetic treatment is as necessary as local measures.

Fortunately, the cornea is very tough and resistant, as it is the part of the eye most exposed. It is washed with tears continually to clear it of small particles of dust and keep it polished and transparent. It is frequently the seat of injury, and affords a common location for lodgement of foreign bodies.

It is not uncommon, among persons who have not made a careful study of the eye, for white scars on the cornea resulting from injury or disease to be mistaken for cataract. Old corneal opacity cannot be removed, and is a prominent cause of incurable blindness; in fact, in former years the greater number of inmates of blind asylums owed their trouble to opacity of the cornea following either "sore eyes of the new-born" (ophthalmia neonatorum) or smallpox.

Arcus senilis is a circular opacity at the periphery of the cornea, seen generally in aged persons. It is sometimes mistaken for beginning cataract. It is the result of a senile, degenerative process, and is not dangerous to the eyeball, and never interferes with vision, as it is so far removed from the center of the cornea.

The sclera is the external tunic of four-fifths of the eyeball. It is continuous with the cornea in front. It is an opaque, tough fibrous membrane, and forms the chief support of the eyeball. By reason of the white appearance of its anterior surface it is commonly called the "white of the eye" (Fig. 38).

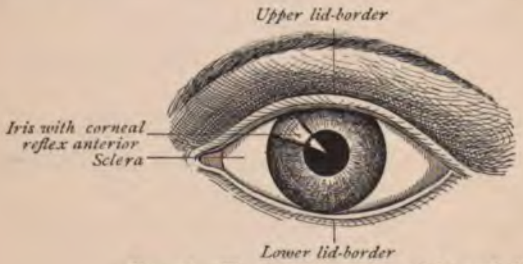

FIG. 38.—The anterior surface of the eyeball.

The iris (Fig. 38) is a circular contractile membrane made up of elastic and muscular tissue, blood-vessels, and nerves suspended from the edges of the cornea in the front of the eye like a curtain. The iris gives the color to the eye; and when we say that an eye is blue or brown we mean that this is the color of the iris. This color of the iris is derived in part from a purplish pigment, and is due in part to certain optical phenomena of reflection of light from uneven surfaces. The iris is freely movable, and according to whether it dilates or contracts we have an alteration in the size of its central aperture, called the **pupil**.

The color of the iris at birth is blue, which, however, changes in the first few weeks to the permanent color. In albinos there is an absence of pigment in the iris as well as in the hair and skin, allowing the red reflex from the blood-vessels in the choroid to shine through, giving the eyes a pinkish hue. As a particular function of the pigment of the iris is to prevent transmission of light-rays through its substance to prevent dazzling, in albinos there is great distress on exposure to light. There is a popular superstition that certain colored eyes are stronger than others. There is nothing in this belief other than that a dark-colored iris is perhaps better fitted to protect the retina from intense sun-glare, and hence is found more among the tropical nations, while light-colored eyes are more general among the northern races. In our climate bluish or grayish eyes may be as serviceable as those of darker color.

The chief function of the iris is by contracting and dilating to regulate the amount of light admitted to the interior of the eye. This has a protective as well as an optical purpose. In the presence of a strong light the pupil quickly contracts, shutting out excessive light; while in subdued light or semi-darkness it dilates, allowing more light to enter. When looking at a distance or when looking languidly into space the pupils dilate. Artists take advantage of this fact, and in portraying pensiveness or reverie paint large pupils in the eyes. In using the eye at close range the accommodation is brought into play in a manner described later (page 208), and the pupil is also contracted, allowing more distinct vision. The optical principle herein may be easily demonstrated by anyone with defective vision who will look through a pin-hole in a disk or card. They will see almost as distinctly as with their glasses, although, of course, they do not have as great a field of vision.

Any interference with the movements of the pupil indicates either inflammatory synechiæ or serious brain- or nerve-disease. However, the pupil may become dilated and inactive after the use of certain drugs called **mydriatics.** Among these are belladonna and its alkaloid atropin, cocain, and homatropin. **Miotics** are drugs which contract the pupil. Among these are calabar bean and its alkaloid eserin, pilocarpin, and opium. One of the prominent symptoms of profound opium-poisoning is pin-point contraction of the pupil, which dilates just before death.

The Size of the Pupils.—In health the pupils are of equal size and react to light synchronously, but there is great difference in the normal size in different persons. Late in life the pupil grows gradually smaller, in a measure compensating for the ocular defects incident to age. Marked inequality in the size of the pupil is generally, though not always, indicative of serious brain- or nerve-disease.

Large pupils are generally and properly considered a sign of beauty, and it is sometimes the practice among actresses, singers, and other women who appear in public to produce an artificial dilatation by the use of a weak mydriatic solution. A large pupil indicates a particularly active sympathetic system, and persons with large pupils are more subject to asthenopia from astigmatism or other refractive defects. It is in such people that insignificant correcting lenses produce the most marked beneficial effects. Strong emotions and passions cause dilatation of the pupil. The typical picture of fright is a dilated pupil with widely parted eyelids.

Ordinarily the pupil appears black. Rays of light entering the eye through a pupil are reflected back in the same direction in which they enter; and as our own eye is not the source of light or in line with the source of light the pupil appears black. When, however, the observer's eye is artificially made the source of light, and if he looks in the same direction as that

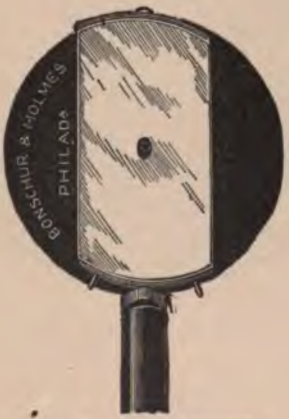

FIG. 39.—Ophthalmoscope.

in which the luminous rays enter the observed eye, as, for instance, through the central sight-hole of a reflecting mirror (Fig. 39), illumination renders the interior of the eye visible. This is the fundamental principle of the **ophthalmoscope**; and the simplest form of ophthalmoscope is a mirror in the center of which is scraped an opening in the silvered back, through which the observer looks at the eye under observation. By directing the reflection of a lamp- or gas-flame into the observed eye and looking through the sight-hole in the mirror there is seen the red reflex of the choroid in the pupillary space, and by coming closer to the pupil there may be seen the blood-

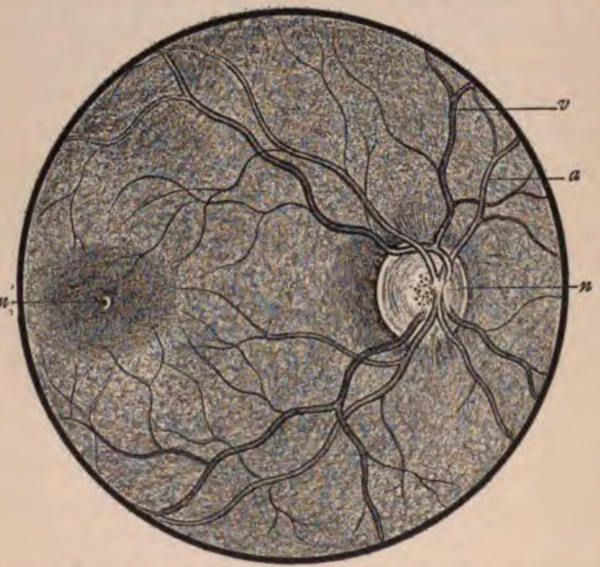

FIG. 40.—The normal eye-ground as seen with the ophthalmoscope: *n*, optic nerve-head; *m*, macula; *a*, retinal artery; *v*, retinal vein.

vessels of the retina and the shining white head of the optic nerve (Fig. 40). This is better accomplished by darkening the room and placing the source of light back of the subject's head, as the pupil then becomes dilated and the contrast is greater.

By subdued light the pupils of certain animals present a bright glare. This is particularly noticeable in the domestic cat, and is due to reflection from a modified choroid, called the tapetum lucidum, a brilliant greenish reflecting membrane between the retina and sclera.

Inflammation of the iris is called **iritis,** and is a very painful and dangerous disease, sometimes causing blindness. At the onset it resembles conjunctivitis, and is often attributed to "catching cold in the eye." The patient should not attempt to treat it by home remedies or common eye-lotions, until the disease has been allowed to progress so far as to bind the iris down to the lens-capsule. In such cases a few drops of atropin solution applied under the guidance of a skilled oculist would render this accident impossible.

The ciliary body is situated at the junction of the iris and choroid, and is quite susceptible to diseases affecting either membrane. It is composed of sixty or seventy folds formed by reduplications of the choroid at its anterior margin, called the **ciliary processes,** and a grayish transparent band of muscular tissue about one-eighth inch broad, called the **ciliary muscle.** This consists of radiating and circular fibers, the former arising from the junction of the cornea and sclera, passing backward to the choroid opposite the ciliary processes; the latter are internal, and pursue a circular course around the insertion of the iris. This little muscle is an important factor in accommodation and eye-strain, and is spoken of at length later (see page 210).

The choroid is the vascular and pigmentary tunic of the eyeball investing the posterior five-sixths of the globe, extending as far forward as the cornea and developing ciliary processes from its inner surface anteriorly. It lies between the sclera externally and the retina internally. Its function is to supply blood to the interior of the eye and to absorb superfluous light. Inflammation of the choroid is called **choroiditis,** and is generally the result of systemic disease, particularly of the type accompanied by disease of the blood-vessels. Other causes are injury, infection, high myopia, retinitis, and iridocyclitis. Disease of the choroid is particularly disastrous to vision on account of involvement of the contiguous membrane, the retina, and the continuous structures, the ciliary body and iris.

The retina is the innermost of the three coats of the eyeball, and is the chief peripheral portion of the visual apparatus. It is made up of the percipient end-organs and expansion of the fibers of the optic nerve in the eyeball. It is composed of three main layers: the inner, of fibers and nerve-cells; the granular middle layer; and an internal layer, composed of rods and cones and pigment. The rods and cones are the essential sight-elements. The light entering the eyeball through the pupil impinging on the cones is received and transmitted through the other layers to the optic nerve, and thence on to the visual centers in the brain. The retina is freely supplied with blood-vessels.

The most sensitive part of the retina is the **macula lutea,** or central spot, which covers an area of about one-fiftieth of an inch in diameter, to the temporal side of the entrance of the optic nerve. In the very center of this part of the retina is the fovea centralis, in which all the layers are missing but the essential cones. So important is this minute portion of the membrane that if it is encroached upon and destroyed by disease, useful vision is lost, although the peripheral part of the retina may be intact. In such a case, if the patient looked directly at an object he could not see it, although he would have an indistinct view of the objects at either side of it. It can be readily understood how helpless in reading or working at close range such a person would be. On the other hand, considerable areas of the surrounding retina may be destroyed and yet useful vision be preserved, provided the macular region is intact, the extent of side vision only being limited. However, defects in the retina may cause blind spots in the field of vision, called **scotomas.** There is a natural blind spot at the entrance of the optic nerve. This may be demonstrated by experiments with the cross and circle described on page 193.

The retina has often been compared to the sensitive plate of a camera, and from this comparison have arisen such absurd statements as the finding of a photograph of a murderer in his victim's eye. The retinal images are not permanent, as witnessed by the numerous and rapid succession in which they change. However, even this rapidity has a limit. If we take a firebrand and twirl it around rapidly in front of the eyes, it is impossible for the eye to perceive the images of the fire in each position of its revolution; and instead of several pictures of the burning brand we see only a circle of fire. That retinal images have some permanency of duration, however, is proved by looking intently at a luminous object for some time and then turning the gaze against a black wall or ceiling for a moment, when there will be seen the image of the object still before the eyes against the new surface. No one has ever discovered a retinal image, and to see it in the eye of a human being as described in sensational newspaper reports the observer would have to use an ophthalmoscope, otherwise these retinal images would be invisible. To be seen with the naked eye, the image must be located on the cornea or iris, and for an image to be placed here would require the interposition and accurate adjustment of a convex lens between the face of the assailant and the eye of the victim—a most preposterous supposition.

The optic nerve connects the retina with the brain. Its sole function is to carry sensations of light. It does not convey the sensation of pain. Disease or injury to the retina and optic nerve may occur to such an extent as to cause blindness without the victim ever suffering the slightest local pain. When suddenly shocked, the optic nerve, instead of giving a sensation of pain, gives rise to indefinite sensations of light, such as are commonly known as "seeing flashes" or "stars." Unlike the retina, the optic nerve cannot receive impressions of light any more than a telegraph wire can receive and interpret a message. They are both only means of conveyance of impressions. In fact, at the point in the eye-ground where the optic nerve enters there is a normal blind spot which, projected into the field of vision, constitutes the well-known **"Mariotte's blind spot."** This may be readily demonstrated by directing the right eye accurately to the cross in Fig. 41. Closing the left eye and withdrawing the page to about ten inches from the eye the circle will entirely disappear, for at this point the image of the circle falls directly on the unresponsive optic nerve-head.

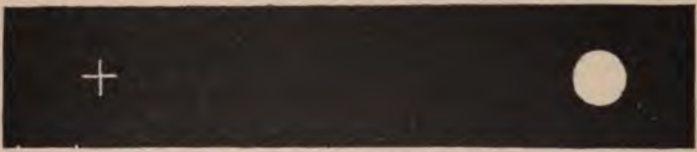

FIG. 41.—Diagram to demonstrate the "blind spot."

Serious disease of the optic nerve, by interrupting the means of communication between the retina and brain, produces blindness. It is generally the result of systemic disease, but may be due to the excessive use of alcohol, tobacco, or other noxious substance. Complete atrophy of the optic nerve is an incurable disease, and when total there is not even perception of light left, and sometimes contrast between bright light and darkness is lost.

The humors making up the bulk of the eyeball are called the aqueous and the vitreous. They are both perfectly transparent for the free transmission of light. The aqueous humor occupies that part of the eyeball in front of the crystalline lens and is a slightly alkaline watery fluid. The vitreous humor occupies the large part of the eyeball lying behind the crystalline lens and is a jelly-like substance. Disease of the various membranes of the eyeball may disturb the transparency of the humors, causing either diffuse clouding and blindness, or only single floating opacities showing as **dark spots before the eyes.** These are, however, quite visible to the physician by the ophthalmoscope, and must not be confounded with the microscopic opacities known as **muscæ volitantes** that are often present in healthy eyes. These smaller opacities are invisible by the ophthalmoscope, but are readily seen by the patient, particularly if he is myopic. They are brought out much plainer in looking against a light wall, a white surface, or at the sky on a clear day. In certain cases of eye-strain they become very annoying and assume different shapes, such as strings of beads, rings, flakes, etc., floating down before the eye. In some patients they are complained of worse during attacks of "biliousness." These dark spots before the eyes are variously considered as intra-ocular evidence of waste-tissue accumulation, the results of sexual disturbances, etc. Although they become very terrifying to the patient at times, as a rule they speedily diminish or become ignored when the defective eyes are corrected by the proper glasses and there is rest from excessive ocular labor.

The crystalline lens is a biconvex transparent body about one-third of an inch long and less than half as thick, enclosed in an equally transparent, homogeneous capsule. It rests against the vitreous, and is partially covered in front by the iris. It is held in place by the suspensory ligament. The substance of the lens is arranged in concentric layers composed of minute fibrils which dovetail into each other. This arrangement gives the lens somewhat the power of a watch-spring, which, when allowed to relax by the contraction of the ciliary muscle, becomes more convex anteriorly. This phenomenon is spoken of later in describing accommodation (page 208).

Cataract is opacity of the crystalline lens or its capsule, and may be partial or complete. It is not an incurable disease, and does not always cause blindness. It is not a "growth on the eye," and it must not be confounded with corneal opacities. In cataract the cornea is transparent and the iris and pupil are readily seen; but the pupil, instead of being black, is grayish-white, and the vision may be reduced to the mere recognition of light and darkness. Many people have unripe cataract and are never cognizant of the fact, because that part of the crystalline lens in front of the pupil never becomes opaque. Only a few opaque radii may be seen when the pupil is dilated by a mydriatic. Too much stress cannot be laid upon this fact, as often the oculist, after failing to improve the vision with glasses, is compelled to explain to the patient the reason of his failure, and if the patient is nervous he imagines he has a horrible growth akin to cancer elsewhere, and will become permanently blind. With prescription and frequent changing of the proper glasses, together with the best hygienic precautions and careful systemic treatment, incipient cataract may not only fail to grow worse, but actually clear up to a slight degree. Again, so long as vision remains good in one eye there is no necessity of operating on its cataractous fellow.

The causes of simple senile cataract are not exactly known. Old age predisposes to it, but whether by weakened nutrition, general arterial sclerosis, or undue strain on the accommodation in presbyopia, we are unable to say definitely ; but certain it is that cataract is seen less frequently where the care of the eyes is properly understood. It is rare among persons of the better classes who have been careful of their eyes and who have used lenses ordered by competent oculists at frequent intervals, instead of neglecting their eyes or using lenses selected carelessly in an optician's shop or a jewelry store.

It is true that the use of proper glasses, the treatment of associate local or constitutional disease, and the observance of ocular hygiene may retard or prevent the maturing of incipient cataract; but the *treatment of mature cataract by drugs or apparatus is useless.* When once it is complete there is no cure but a surgical operation. There are frequently advertised numerous remedies and treatments "without the knife," which are mostly solutions of some mydriatic, which by dilating the pupils allow the entrance of more light and hence improve vision temporarily. These are all made with the idea of imposing on the credulity of the victims of cataract, who are foolishly ready to try any treatment that may be substituted for the "dreaded operation," which, fortunately, in the hands of a skilful surgeon is almost always successful. The prescribed operation consists in cutting an opening in the rim of the cornea, opening the capsule of the lens, and removing the opaque lens from its bed in the pupillary space. Of course, in the place of the lens removed, an artificial lens must be worn in front of the eye in spectacles ; and as great refractive power as well as the power of accommodation has gone with the natural lens, a separate pair of glasses, or bifocal lenses, must be worn for near work.

Sometimes in the onset of cataract the crystalline lens swells before it begins to become opaque, and by this change in refraction the aged person is enabled to read for the first time in many years without glasses. This is the so-called "**second sight.**" However, if the distance vision is taken it will very likely be found quite defective, and generally the typical opacity of cataract progresses, and if the patient lives long enough vision is almost totally lost, and operation is necessitated.

Glaucoma is a disease of the eye in which the characteristic symptoms are steadily increased hardness of the globe, with pressure and cupping of the optic nerve, and pressing forward of the iris and dilatation of the pupil. It is due either to excessive secretion or blocking of the excretory channels of the eyeball. It is a very fatal disease to vision and is very resistant to treatment. It is most common in females and appears generally after middle life. The local medicinal treatment is application of miotic drugs to contract the pupil and reduce the tension. Atropin and other mydriatics, by dilating the pupil, aggravate the condition, and may hasten an incipient attack. Persons with glaucoma are liable to inflammation of the conjunctiva, and are frequently seeking to change their glasses. The careless and indiscriminate use of popular eye-lotions or eye-drops containing some mydriatic in glaucomatous inflammation, or the administration by an optician or other layman of a mydriatic preliminary to testing for glasses in cases of glaucoma, has caused the loss of many eyes (see page 220).

Injuries to the Eyes.—We have already mentioned the numerous ways in which this delicate and important organ is protected by Nature. The bony orbit and the cushion of fat enclose the eye behind; the orbital margin, eyebrows, eyelids, eyelashes, and nose protect it in front and laterally; while the tough sclera and cornea form coverings not easily penetrated. When a blow or a foreign body is directed toward the eye, automatically by reflex action the lids close and the eyeballs roll up, presenting the tough and opaque sclera instead of the important transparent cornea to arrest the force of violence. In fact, in penetrating wounds of the eye directly through the lids the injury is generally on the lower sclera, the cornea having been too quickly rotated upward and out of the line of contact to be injured.

Non-penetrating Foreign Bodies.—The most common form of injury is the entrance of small particles of dust, cinder, steel-filings, etc., into the conjunctival sac or into the substance of the cornea. Often the tears will wash such particles as are not embedded toward the inner canthus, where they cause no symptoms and can be seen by the patient and wiped out. However, the foreign body may lodge and be hidden from view in the upper or lower sulcus of the lid or be embedded in the cornea, and can only be seen with difficulty by the unaided eye. It will quickly cause intolerable rubbing and grating, which necessitate frequent winking or complete closure of the lid before there is comfort. The eye soon becomes congested and the conjunctiva inflamed. In such cases the surface of the bulbar conjunctiva and cornea should first be inspected in a bright light or by oblique illumination with a magnifying lens. The lower sulcus of the conjunctiva is then brought into

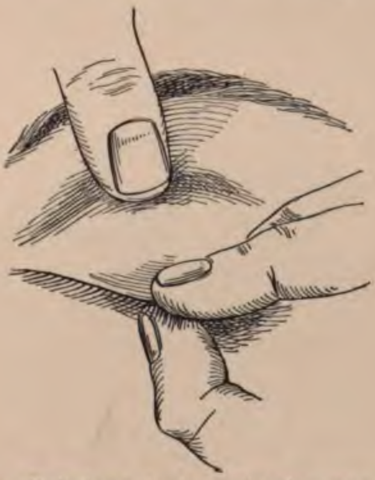

FIG. 42.—Preliminary step in everting the upper eyelid.

view by simple tension on the lower lid downward with one finger. If the offending particle is not seen, the upper lid should be everted (Figs. 42, 43). This may easily be effected without the aid of a probe or other instrument, and everyone should learn the manipulation, as there is often opportunity in travelling to relieve some unfortunate sufferer by this simple procedure. The patient is told to look down, the edge of the lid and the lashes are seized with the thumb and forefinger of the right hand, and the lid is drawn at first forward and then downward away from the globe; then upward over the point of the thumb or forefinger of the left hand, which is held stationary on the lid and acts as a fulcrum. The foreign body should be removed with a handkerchief or wisp of cotton; but if it is embedded it may be necessary for a competent physician to release it with the point of a sterilized needle, or spud, or a magnet under cocain-anesthesia. Embedded particles are most common in marble-cutters, grinders, engineers, firemen, and the like. In every shop there is some workman who is skilled in removing foreign bodies, and who does not in his ignorance of the serious consequences hesitate to pick at the embedded particle with a rusty knife-blade or needle, without previously washing his soiled hands. Destructive corneal ulcers following such manipulations are not uncommonly seen in large eye-hospitals.

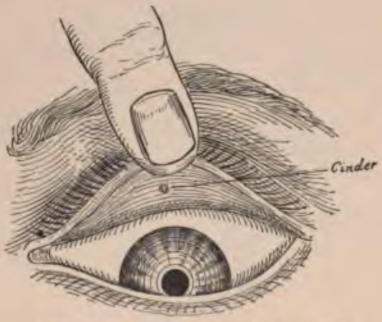

FIG. 43.—The upper eyelid everted.

Penetrating Foreign Bodies.—The dangers of embedded foreign bodies are not the most serious in these exposed trades. The foreign body often completely penetrates the eyeball, destroying vision of not only the injured eye, but sometimes that of its fellow by sympathetic inflammation following delayed or improper treatment. There is no more serious injury to the eyeball than penetration by a foreign body, and often vision is not only lost, but also the eyeball must be taken out to avoid sympathetic inflammation. An eye with a foreign body in it is always dangerous, as it is liable to break out at any time into active inflammation. In spite of these dangers the employés in such hazardous occupations refuse to wear protective glasses. There should be a rule in every establishment where the nature of the work causes many eye-injuries that no employé shall be allowed to work without protective glasses, and casualty companies should refuse to take risks on such employés unless this rule is enforced.

Penetrating wounds of the eyeball are very serious, especially when through the ciliary region, and often necessitate enucleation. If, however, the lens alone is the seat of injury, a traumatic cataract may be the only result, and this may absorb under appropriate treatment without more serious result than follows an ordinary cataract-operation.

Burns of the eye are not uncommon. Usually the conjunctiva and cornea are involved, and immobility of the globe or blindness may follow on account of contraction of the scarred membrane and growing of the raw surface of the lid to the ball, with perhaps opacity of the cornea. Quicklime is particularly dangerous to the eye. The most important treatment in such cases is to remove quickly, forcibly, and thoroughly all the irritating substance. This should be followed by the instillation of a drop of concentrated sugar solution. Afterward, a teaspoonful of sweet oil may be instilled, and is very soothing. In cases of acid-burns, bathing the eye with milk is advised. Immediately after the first emergency treatment the case should be placed in the hands of a physician.

AMETROPIA AND EYE-STRAIN.

The eyeball has very aptly been compared to a camera. Rays of light from a luminous object enter the pupil. The mobile iris acts like the diaphragm of a camera, shutting off rays which are too divergent to be properly refracted, while the remaining rays are focussed accurately on the sensitive surface of the retina by the crystalline lens and other refractive media of the eye (Fig. 44). However, here the analogy ceases, for instead of the retina retaining a permanent impression like the sensitive plate of the camera, it is simply stimulated by the impingement of the light-rays, and the impressions caused thereby are transmitted to the centers of sight in the brain by means of the optic nerve, optic tracts, etc., in a manner somewhat analogous to telegraphy.

It must be remembered that the eyeball does not see. It is only a sensitive end-organ which receives and transmits impressions to the higher centers of sight. The act of vision is performed in the brain.

For the performance of perfect vision the following conditions are necessary: (1) The media of the eye must be perfectly transparent; (2) rays of light entering the eyeball must be transmitted through the pupil and focussed exactly on the retina; (3) the retina, optic nerve, and its continuations must be perfect; (4) the visual centers in the brain must be intact. In other words, the receiving, transmitting, and interpreting apparatus must all be perfect. A disturbance of any component of the visual system may cause defective vision, and even blindness. In cases of cataract, the retina, optic nerve, and brain may be healthy, but the opaque lens behind the pupil prevents light from reaching the retina. In atrophy of the optic nerve or disease of the retina, the media of the eyeball may be perfectly transparent and properly direct rays of light to the retina, and the brain may be healthy, but blindness ensues because

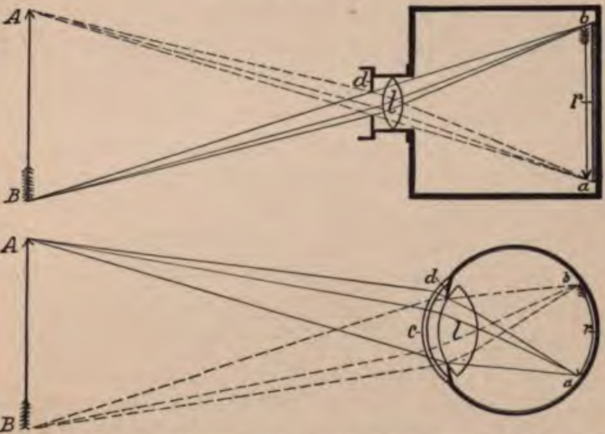

FIG. 44.—A camera obscura and the eyeball compared: *A B*, object; *d*, diaphragm (iris); *l*, lens; *r*, sensitive plate (retina); *a b*, image of *A B*; *c*, cornea.

the impressions either are not received or are not transmitted. In disease of the visual centers of the brain the whole eyeball may be normal and the optic nerve perfect, but blindness results from the inability of the brain to interpret the impressions transmitted to it.

In this discussion it is with the focussing power of the eyes that we are chiefly concerned. This property of bending nearly parallel rays of light from distance and divergent rays from close range so that they meet exactly on the sensitive retina is called **refraction.**

Emmetropia is the refractive condition in which rays of light entering the eyeball from a distance are focussed exactly on the retina. The emmetropic is the normal eye (Fig. 45).

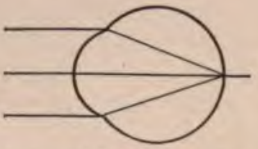

FIG. 45.—The course of light-rays in an emmetropic eye.

Ametropia is the refractive condition in which distant rays of light entering the eyeball are not accurately focussed on the retina. There are three varieties of ametropia: hyperopia (far-sightedness), myopia (near-sightedness), and astigmatism.

Hyperopia (far-sightedness).—In this condition the eyeball is too short, and rays of light from a distance are focussed behind the retina (Fig. 46, *f*). Instead of being distinct as in the emmetropic eye, the image is blurred, and the eye is adjusted for distance rather than close range. Hyperopia is corrected by a convex lens which converges the rays of light, bringing them sooner to a focus.

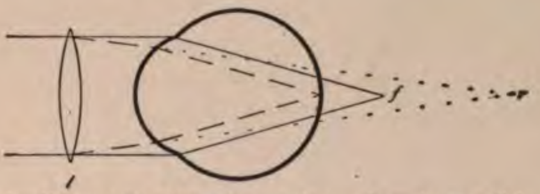

FIG. 46.—Diagram showing a hyperopic eye focussing parallel rays of light at *f*, behind the retina, and *l*, the convex lens, which, converging the rays toward *r*, causes them to be focussed exactly on the retina, thus correcting the hyperopia.

Myopia (near-sightedness).—In this condition, by reason of greater length of the eyeball or increased refractive changes in the media, rays of light from a distance are focussed in front of the retina, producing an indistinct image (Fig. 47, *f*). The myopic eye is adjusted for close range rather than for distance. Myopia is corrected by a concave lens, which diverges rays of light, prolonging the focal distance.

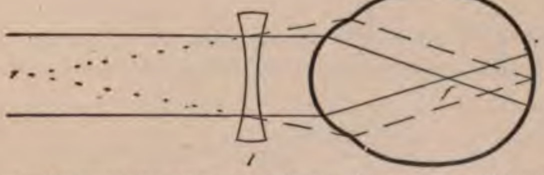

FIG. 47.—Diagram showing a myopic eye focussing parallel rays at *f* in the vitreous, and requiring the concave lens *l*, which will cause them to diverge as from *r*, in order that they shall be focussed exactly on the retina.

Astigmatism is a condition in which the focus may be either in front of or behind the retina, or both, but by different amounts for two or more meridians of the eye. In simple hyperopia or myopia all the meridians of the eye are equally defective. In simple astigmatism one principal meridian is normal while the other is faulty. In compound astigmatism both meridians are hyperopic or myopic, but unequal in degree. In mixed astigmatism one meridian is hyperopic while the other is myopic. Astigmatism does not depend on the length of the eyeball, but upon the curvature of the cornea, and rarely that of the lens.

In Fig. 48, a case of hyperopic (far-sighted) astigmatism, the meridian *vv* is normal, focussing at *v′*, exactly on the retina. The meridian at right angles, *hh*, is hyperopic, focussing at *h′*, behind the retina. In this condition a point of light is focussed as a blurred line. Astigmatism is corrected by a cylindric lens, which has a plane surface in one axis and a curved surface in the axis at right angles to it. This

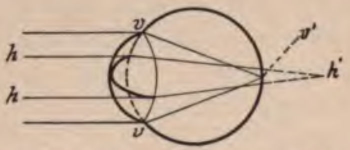

FIG. 48.—The course of rays in simple hyperopic astigmatism: *h h* pass through the hyperopic meridian (after Thorington).

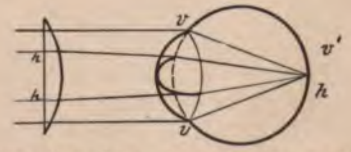

FIG. 49.—Correction of the astigmatism by a convex cylinder.

form of lens is really a segment of a cylinder of solid glass. The axis of the cylinder is placed at right angles to the faulty meridian (Fig. 48, *hh*).

In simple astigmatism, on looking at an astigmatic chart (Fig. 50) with each eye separately, certain of the lines in the defective meridian seem very much blurred, while those at exact right angles appear clear and black. This furnishes a test for astigmatism, as to an emmetropic, or normal, eye the lines appear of equal distinctness and blackness. Astigmatism is very common, and although we speak of hyperopic and myopic eyes separately for purposes of optical explanation, it may be stated that nearly all eyes in highly civilized communities, irrespective of their length, are in some degree astigmatic.

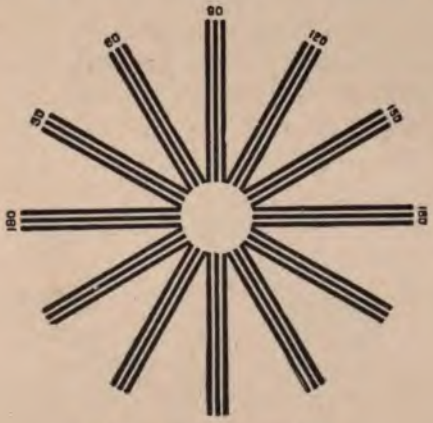

FIG. 50.—Astigmatic chart.

Accommodation.—Until now we have spoken of the eye as an organ at rest, focussed for nearly parallel rays from a distance. Close to the eye the light-rays have an appreciable divergence; yet we know that notwithstanding the inadaptability of the eye for focussing such rays it is quite possible up to middle age to receive distinct retinal images of objects within a few inches of the eye. This change of focus is effected by an act called accommodation, which is accomplished by an increase in the convexity of the crystalline lens behind the pupil. This lens is held in place by its suspensory ligament, the tension of which is controlled by the **ciliary muscle.** During accommodation the ciliary muscle contracts, relaxing the suspensory ligament, and the lens bulges forward by its inherent elasticity and the refractive power is increased (Fig. 51). By means of accommodation all reading, writing, sewing, and other near work is made possible. The power of accommodation is greatest in early life, and gradually diminishes until about the age of forty, when reading at the ordinary distance becomes uncomfortable. At about seventy-five years the accommodation is practically lost.

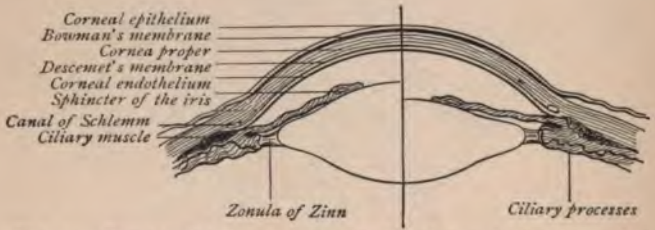

FIG. 51.—Comparative diagram showing the change in the shape of the crystalline lens during accommodation. The right side shows the lens at rest.

This physiologic **failure of accommodation** beyond the point of comfortable reading is called **presbyopia, or old-age sight,** and every person over forty-five years with normal or far-sighted eyes should wear glasses to read and perform other ocular work. Presbyopia is corrected by convex glasses, which must be strengthened every few years. The presbyopic correction must be used in addition to any distance-correction. Old persons cannot wear the same glasses for distance and for near.

Near-sighted persons, although unable to see distinctly at a distance, are enabled by the increased refractive power of their eyeballs to read without glasses even in old age. Sometimes the distant point of a near-sighted eye is as close to the eye as the ordinary reading-distance (twelve to fourteen inches), and in such cases reading is effected without accommodation at the far point of the eye. Whenever a person is heard boasting of the ability of himself or some relative to read in old age without glasses, it may be taken for granted that, instead of the vision being extraordinarily preserved, the eyes are near-sighted, and perhaps all through life, distance-vision without glasses has been imperfect, although reading and near work were distinct.

Anisometropia, or marked difference in the refraction of the two eyes in the same person, is not unusual; in fact, one eye may be far-sighted and the other near-sighted, and yet the patient, being able to read at a distance with the far-sighted eye and at close range with the near-sighted one, may go through life never realizing that the eyes are [illegible] person [illegible]

[illegible] conscious

[illegible]

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the incessant loss of nervous vitality in eye-strain a chain of symptoms collectively known as **asthenopia.**

The multiformity of the effects of eye-strain can only be properly realized when we understand how vital the function of vision is to every act, emotion, or thought. The visual centers are in the closest connection with the other brain-centers, and the slightest disturbance of the visual mechanism, particularly if the eyes are used excessively at close range, produces sympathetic irritation not only in the eyes, but in the entire motor, sensory, and psychic systems. Happily the manifold effects of eye-strain, so long ignored, are being better appreciated every day, and cases of chronic inflammation of the eyes and persistent headaches are quickly sent for examination of the refraction of the eyes instead of being dismissed with a time-worn formula for medicine.

The Local Symptoms of Eye-strain.—There may be a continual sense of discomfort in the eyes, which organ may even become very painful if used for near work. After a few moments of reading the type blurs and the letters run together, and there may be a difficulty in following the lines. There may be twitching of the eyelids, and in extreme cases there may be great difficulty in keeping the eyes open in continued reading on account of drowsiness. The eyes may smart, itch, or burn, and continually "water;" or they may appear red and congested both on the edges of the lids and in the conjunctival sac. There may be great sensitiveness to light, causing the misguided patient to wear colored glasses instead of the correcting transparent lenses.

The General or Reflex Symptoms of Eye-strain.—One of the commonest reflex asthenopic symptoms is headache, particularly that accompanied by nausea ("sick-headache") and made worse by reading, sewing, riding in the cars, riding backward, shopping, attending the theater, etc., although often there seems to be no particular connection with excessive use of the eyes. The headache is usually temporal or frontal, but it may be on the top of the head or at the base of the skull (occipital). The headache may be of the neuralgic type, and may be limited to one side, and then not always on the side of the more defective eye.

In some cases the reflex disturbances are quite remote from the eyes, and escape connection with eye-strain. Obstinate constipation and indigestion are occasional manifestations of eye-strain. Vertigo, general nervousness, nervous prostration, insomnia, and even chorea and epilepsy are some of the influences of asthenopia on the nervous system. In fact, the general health may be so impaired by the continual nervous drain of eye-strain that the most serious systemic debility may result. Unless the patient has been under the care of a skilful physician, who recognizes the influence of eye-strain, he may be medicated, massaged, dieted, and given many other forms of treatment before the services of an oculist are sought.

The liability to overlook eye-strain as a reflex cause in systemic troubles is in no small degree due to the fact that often when the reflexes are most prominent there is little or no local disturbance to direct the attention to the eye, and the same is true of the contrary. It may be mentioned here that often patients with prominent eye-symptoms may persistently seek relief from local treatment when the cause is not ocular. For instance, patients are sometimes given glasses by unscrupulous opticians for conjunctivitis which may be of purely nasal origin. Again, there is pain deep in the orbit, associated with a dull headache, particularly distressing on arising in the morning, in some varieties of uterine disease. The orbital pain and brow-ache of malarial fever may be mistaken for an asthenopic reflex. However, the history of chills and fever will prevent a physician from making a false diagnosis. In the early stages of locomotor ataxia the eye-symptoms may be carelessly dismissed with a prescription for glasses, allowing the disease to progress unrecognized. Such cases are unanswerable arguments for the necessity of medical supervision in the diagnosis and treatment of eye-strain.

The Eye-strain of Myopes.—We have spoken heretofore of the asthenopia due to hyperopia and astigmatism which may be unrecognized on account of preservation of perfect vision. There is still to be considered myopia, in which near vision may be comfortable although the distant vision is faulty. No amount of eye-strain will improve the distance vision, because the more a near-sighted person strains the ciliary muscle the more myopic he becomes. It would naturally be supposed that such a person would immediately seek relief from an oculist on account of poor distant vision. On the contrary, many near-sighted persons, not being accustomed to any better distant vision, and being able to perform the finest work without effort, are likely to boast of their strong eyes. When given correcting-glasses they may even discard them, saying, perhaps, that objects at a distance look unusually bright or clear, but that they prefer the old familiar haze.

Despite all arguments to the contrary, the myope is quite as much in need of glasses as the hyperope or the person with simple astigmatism. On account of the stretching of the ocular coats the nutrition of the structures of the eye is disturbed and often the membranes are vitiated almost to a point of true disease. In reading, the myope is inclined to hold his book close. In so doing he strains his muscles of convergence, producing ocular congestion and compression of the eyeball, and by bending over he affords a favorable position for distention of the ocular veins. Contrary to popular impression, the uncorrected myopic eye may be considered a "sick eye," and unless restrictions are made as to the amount of near work performed or unless the proper glasses are ordered, permitting reading at a safe distance from the eye, serious progress of the myopia with accompanying intra-ocular disease may occur. It is particularly necessary to pay the strictest attention to school hygiene (see page 233), and to correct repeatedly the constantly changing refraction of the eyes of school-children in order to prevent the serious higher grades of myopia. Moderate degrees of myopia which have been properly cared for may never cause the patient any discomfort other than the necessity of wearing glasses constantly. Even if there were no danger of the progress of myopia or intra-ocular disease, the slight inconvenience of wearing glasses is many times offset by the improvement in distant vision, allowing participation in outdoor sports and in the pleasures of Nature.

The Ocular Muscles.—The eyeball is moved by six muscles, namely, the superior, inferior, internal, and external recti, and the superior and inferior obliques (Fig 52). The disorders of the ocular muscles are of sufficient importance to be mentioned here, particularly as squint, muscular imbalance, and muscular insufficiency are mostly due to ametropia, notwithstanding popular beliefs to the contrary; and they may be prevented by the early prescription of glasses, and often alleviated or entirely cured by the same treatment. Paralysis of the ocular muscles is usually the result of serious systemic disease.

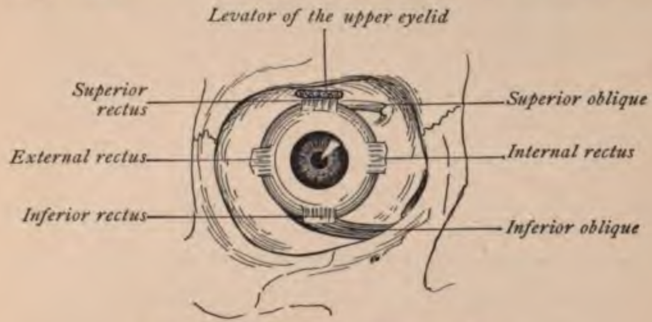

FIG. 52.—The external ocular muscles.

When the visual axes of the two eyes meet exactly at the point of observation, the ocular muscles are said to be balanced (Fig. 53). This muscular balance is maintained by the perfect anatomic conformation of the muscles and equally distributed innervation to them. Any disturbance of these factors upsets the muscular equilibrium. If the insertion or structure of a muscle is faulty, or if the innervation is anomalous, **muscular imbalance,** or **heterophoria,** is produced. This, however, does not imply that binocular fixation becomes impossible. On the contrary, the visual axes may be rightly directed by increased innervation, and single vision maintained in ordinary work. In true **strabismus** **or squint,** or permanent deviation (Fig. 54), this is not possible, and **diplopia (double-vision)** is only avoided by the use of correcting prisms or by forcing one eye from participation in the visual act. In other words, in true strabismus, perfect binocular vision is impossible without optical assistance, while in ordinary muscular imbalance, or heterophoria, binocular vision is maintained by increased innervation. In the first, the anomaly is in some part

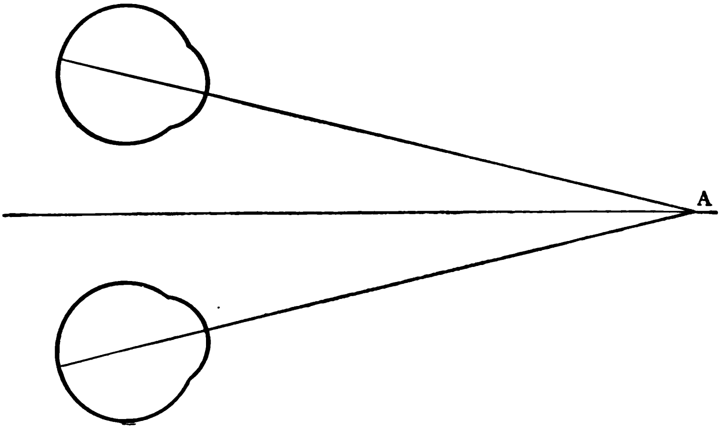

FIG. 53.—Diagram showing the eyeballs in proper position during convergence, the visual axes exactly meeting at A.

organic; in the last, exclusively functional. The importance of the study of the functional anomalies of the ocular muscles is manifest when we realize that the extra expenditure of nervous energy in maintaining perfect binocular vision causes asthenopic and reflex symptoms quite as annoying as those due to errors of refraction.

The cause of muscle-deviations is almost always a refractive error. For many years it was supposed by some authorities that the defect was anatomic; that the muscles concerned were too short, too long, or anomalously inserted or attached; and that the only remedy was surgical intervention by means of section of the tendon (**tenotomy**) and **advancement.** To-day, we know that in all cases of muscular deviation not the result of paralysis, the prescription of the proper glasses is the first treatment. In young

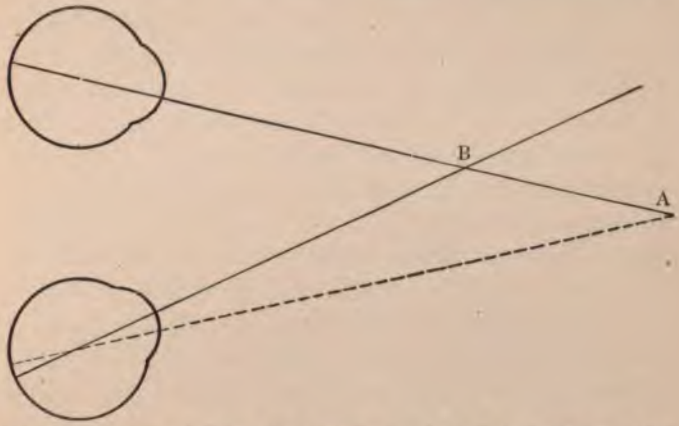

FIG. 54.—Diagram showing the eyeballs in a case of strabismus. The visual axes meet at B instead of at A.

children the squint will usually disappear after the glasses are worn, but if correction of the ametropia and properly prescribed exercises do not restore muscle-equilibrium after several months, then the surgical measures may be tried.

The involuntary, or automatic, movements of the eyes, such as the rotation in reading, are intimately associated with the act of accommodation. For instance, when a book or paper is brought close to the eye there is an innervation to the ciliary muscle, forcing it into action, thus changing the focus of the crystalline lens, so that it will receive rays of light from the near object and place them exactly upon the macula of the retina. At the same time the two eyes must converge in order that their visual axes shall meet exactly at the near object; otherwise there would result confusion of images, or diplopia. In the same way the eyes must be rotated in or out, up or down, with a definite exactness, according as the object is held to the right, left, above or below the vertical and horizontal visual planes, otherwise the visual axes would not meet exactly at the point of observation. Whether congenital, or by long habit—the development of automatism—these movements of the eyeball are intimately associated, likely controlled by one center or contiguous centers, as far as participation in near work is concerned, and there is a constant relation maintained between the acts of accommodation and ocular movement. This is particularly so with convergence, and long ago the theory of squint by excessive stimulation of the adduction (convergence), associated with excessive accommodation in hyperopic eyes, was propounded, and has never been successfully controverted. The same is true of muscular imbalance. Attention to the ametropia often speedily relieves the muscle-defect. It is careful refraction, and not surgical operation, that prevents and cures most of these cases. If operation should restore muscle balance, the uncorrected causative eye-strain is still operative, and unless corrected by glasses there may be a recurrence of the deviation, or equally serious reflex asthenopic symptoms may ensue.

The reason that oculists use mydriatics, or "drops," as they are popularly called, in measuring the refraction of the eyes is frequently asked for by the laity, and there is a popular impression that from the name they are used only to dilate the pupil. Mydriatics are used in refraction of the eye to produce paralysis of the ciliary muscle; in other words, as cycloplegics. With the accommodation active in far-sighted and astigmatic persons, it is impossible to discover the full defect on account of the continual compensatory strain of the ciliary muscle. Hence by using a substance in the eyes such as belladonna or its alkaloid, atropin, which paralyzes the ciliary muscle and puts the eye in a state of rest, the interference of accommodation is overcome. A far-sighted or astigmatic person with perfect visual acuity when the ciliary muscle is active, will see as poorly at distance under a mydriatic as an equally near-sighted person, because of ciliary paralysis (cycloplegia); and as there is no ability to strain left, the full amount of the defect is unmasked. Without a mydriatic, far-sighted and astigmatic persons refuse their full correction, while near-sighted persons are liable to select glasses too strong for them. When the accommodation has failed in old age a mydriatic is not necessary, but it is a safe rule to follow, always to use a mydriatic in first refraction of persons under forty-five years of age, and often ciliary paralysis is necessary for accurate refraction of robust patients of even fifty years. Persons advertising to examine the eyes of children and young adults accurately without the use of mydriatics are claiming what is impossible even to the skilled oculist.

The Objections to Mydriatics.—When "drops" are put in the eyes the resultant paralysis of the ciliary muscle makes close work, such as reading and sewing, impossible. When atropin is used this inconvenience is continued for ten days or two weeks, but, contrary to popular opinion, there is no danger attending the ciliary paralysis; in not a single case has it become permanent. Accommodation returns promptly after the effect of the drug has passed off, leaving the eyes better for the rest from near work. The length of time necessary to abstain from near work is now shortened to from thirty-six to forty-eight hours by the use of a new mydriatic called homatropin, which many oculists use in routine practice among adults. In children, time is not so valuable, and as complete paralysis of accommodation is more difficult to obtain, the stronger mydriatic, atropin, is preferable.

There is a disease of middle and later life, called glaucoma, in which the use of a mydriatic may produce very serious results; and opticians, jewelers, and other non-medical "refractionists" who are forbidden by law to use "drops," have made a great card of this fact. This disease is, however, very rare, and is readily recognized by the trained oculist, who always makes careful external and ophthalmoscopic examination before prescribing a mydriatic or ordering glasses. Although there is no danger from the use of "drops" in the hands of the skilled physician, their promiscuous employment by itinerant opticians, jewelers, peddlers, and the like, may result disastrously to persons with glaucoma, who by reason of their failing vision are particularly likely to be seeking a change of glasses.

VISUAL TESTS.

Testing the Acuity of Vision.—It has been proved that the smallest retinal image perceived at the macula corresponds to a visual angle of 5′. Following this principle, **test-types** have been constructed in such a manner that every letter is so made that when at its proper distance it subtends an angle of 5′. The letters in Fig. 55 subtend an angle of 5′ when placed about twenty feet from the eye, and should be read easily at that distance if the eye is normal. For illiterate persons and children, a card containing characters such as in Fig. 56 may be used. The patient is asked to tell which way the prongs of the E point—upward, downward, to the right, or to the left.

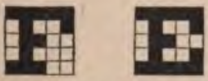

FIG. 55.—Two of Snellen's test-types.

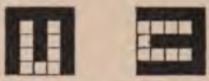

FIG. 56.—Test-type for the illiterate.

The only article required in testing distant vision is a series of test-letters (Fig. 57) so arranged that they subtend an angle of 5′ at varying distances from 10 to 200 feet. The distance may also be expressed in meters. These cards may be procured for a merely nominal sum at any optical store. Figs. 55 and 56 placed at 20 feet distance may be used by the reader for the simple purpose of finding out whether or not vision is normal.

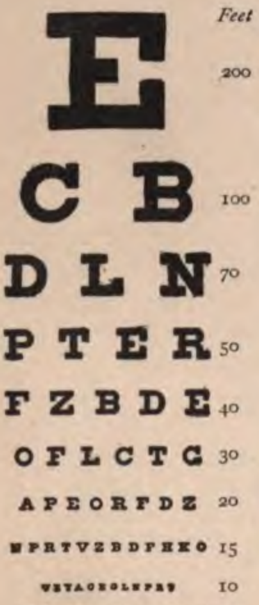

FIG. 57.—Reduced illustration of an ordinary card of test-letters for measuring the acuity of distant vision.

In using the large card of test-letters, it is fastened to a hook or nail about 6 feet from the floor, and about 20 feet from the chair in which the patient is seated. The letters of the 20-foot line are then about on the level with the patient's eye. The card must be well illuminated by daylight or artificial light. The 20-foot distance is not necessary; 12 feet will answer, but in this case we must bear in mind that the patient should read several lines lower. *Always examine each eye separately.* Seat the patient facing the card; direct his attention to the test-letters; cover the left eye with a small card and ask him to read on the test-card as low down as possible. Note the lowest line read correctly or nearly so, and then cover the right eye and test the left in a similar manner. Register the findings as follows: If the card is hung at 20 feet distance, use 20 as the numerator and the number of feet at the side of the lowest line read as the denominator. This gives the *visual fraction.* For instance, if the patient reads the line marked 40 feet (that is, consisting of letters subtending an angle of 5′ at 40 feet), his visual fraction is $\frac{20}{40}$. Any fraction less than $\frac{20}{20}$ indicates defective vision.

But it must be borne in mind that *the mere fact of the patient reading the* $\frac{20}{20}$ *line is no assurance of the absence of refractive error.* The patient may be hyperopic and astigmatic (if in youth, to a very considerable extent), and still read the $\frac{20}{20}$ line by means of his accommodation, and it is this very extra strain that causes the distressing asthenopic symptoms. This can be definitely determined only by the use of a mydriatic.

If the patient already wears glasses, and with them he cannot read with each eye separately $\frac{20}{20}$, he should consult an oculist. If there is considerable difference of vision in the two eyes, there is great likelihood of eye-strain.

If the symptoms cannot be traced to any other cause, or if the patient uses the eyes excessively or viciously, or if the symptoms are especially referred to the eye, even though the vision appears normal or properly corrected with glasses, the physician should put one drop of a 2 per cent. homatropin solution into one eye every five minutes for a half hour, and then if the vision falls to any great extent the patient is ametropic, likely hyperopic or astigmatic. Myopic persons without astigmatism see about as well at a distance under a mydriatic as with the accommodation functional.

If the patient is young or is not compelled to use the eyes in his daily vocation, and complains of persistent eye-pain or headache untraceable to other causes, the eyes should be put at rest under atropin for ten days, and tested. This is accomplished by the instillation three times daily for two days of one drop of a 1 per cent. solution of atropin into each eye. If the vision falls under the mydriasis, or if the symptoms are relieved, the diagnosis of ametropia is positive.

Testing Accommodation.—The small reading test-card or paper is brought slowly up before each eye separately, the other being covered, and the patient is told to fix his gaze on type of about the size shown in the following paragraph:

Measures preventing the development of myopia consist in the careful examination of children's eyes, particularly about the time they are to start to school, and in securing the best hygienic conditions for them during their school hours. Good ventilation, properly constructed desks, and sufficient and rightly directed light

If he is younger than 21, he should be able to read the type easily at from 5 to 7 inches distance, otherwise he is considerably hyperopic or has some extra disturbance of the ciliary muscle, and his case is one for an oculist. If the patient is middle-aged and cannot see the type easily at 10-12 inches, he is either presbyopic or hyperopic, and is in need of reading-glasses. If there is a discrepancy in the reading-power of the two eyes, the case is especially one for an oculist. If the patient has very poor distant vision, but can read the type easily at 5 inches, he is a myope. If the patient is already wearing reading-glasses and the type cannot be read with each eye at 10-12 inches, his glasses are not strong enough.

If he cannot read the type with his glasses at a distance of at least 14 inches, his glasses are too strong.

Color-blindness.—Total color-blindness is very rare. In such cases the entire solar spectrum appears grayish. Partial color-blindness is generally congenital. It is often hereditary, and sometimes skips several generations. The discoverer of color-blindness was Dalton, a distinguished professor of chemistry, who himself was color-blind, a fact which he ascertained by accident.

Acquired color-blindness may be the result of disease or accident. Defective color-sense often appears after disease of the optic nerve, and is a particular symptom in optic neuritis and atrophy due to excessive use of tobacco and alcohol. However, central color-blindness may be seen in all forms of toxic amblyopia. A peculiar point to be noted in tobacco-amblyopia is the fact that the patient may be able to distinguish colors close to the eye, but when they are farther removed he is color-blind, particularly for green and red. This makes it quite important to test for color-blindness at the normal signal distance in addition to the skein-test at close range. Color-blindness is sometimes the result of injury; occasionally, after blows upon the head, color-blindness is noticed in one-half the field of vision only, the other half being normal in its color-perception.

Partial color-blindness is quite common. Statisticians tell us that the proportion is 1 : 25 among males, and 1 : 400 among females. There may be blindness to blue, yellow, red, or green. However, the colors that most often fail to make proper impressions are red and its complementary color green. These colors do not appear as absolutely black, but they cannot be distinguished from one another and from certain shades of gray and brown. In extreme cases there is total blindness for red and green, and even the brightest shade of red cannot be distinguished from green. Unfortunately, the colors most often at fault are those selected by railroad companies and navigators as their signal colors; hence, we see how important it is for the employés of transportation companies to have the color-sense absolutely perfect.

In the ordinary **Holmgren test,** the person is given a test-skein of wool of a light-colored pink, and told to select (and not name) from a mass of similar skeins those which most nearly resemble the skein to be matched. If he is color-blind, he will confuse the grays, the greens, the pinks, the browns, and the reds. As a confirmative test he is then given a light, pure green skein to match in the same way. It is presupposed that the examiner is not at all color-blind.

Dr. William Thomson has devised a convenient apparatus for testing for color-blindness, which has been widely adopted by railroad examiners. It consists of a stick to which numerous bundles of yarn are attached, a light green being used as the test-skein. The method of using the **Thomson stick** is described by its author as follows: Using the light-green test-skein, the patient under examination is asked to match it in color from the yarns on the stick, which are arranged in alternate green and confusion-colors, and which are numbered from one to twenty. The selection of ten tints is required, and the examiner notes the number of the tints chosen.

The odd numbers are green and the even ones the confusion-colors. If the patient has a good color-sense, his record will exhibit none but odd numbers; if he is color-blind, the mingling of even numbers betrays the defect. To distinguish between green-blindness and red-blindness, the **rose-test** is used, and the color-blind patient will select, indifferently, either the blues intermingled with the rose, or, perhaps, the blue-greens or grays. Finally, the red test is used as a control.

There are other color-tests, but these two are sufficient for practical purposes. The field for vision for different colors is tested in the same manner as the field for white, using a colored object instead of a white one.

Tests for Blindness.—Hysteric amblyopia is not uncommon, but very many cases so diagnosed are properly the sequence of asthenopia. Malingering by the declaration of amblyopia or blindness may be found in insurance-examinations and in military life, and often to procure damages after alleged injuries. Many ingenious devices have been adopted to expose the simulant, all depending upon the fact that in ordinary visual perception there is no account taken of the exact participation of the two eyes. If we hold a book before the patient's eye and interpose a pencil in front of the eye supposed to be active, the reading will be slightly interrupted if the left eye is amblyopic; if, however, the amblyopia is feigned, the left eye will escape the pencil and the reading will be uninterrupted. Another way is to interpose a highly convex lens in front of the eye supposed to be good, and if the test-type is removed beyond the focal distance of the lens and is still legible, we know that the other eye participates in vision. The production of double images by the interposition of prisms also proves binocular vision. Still another method depends upon colored letters placed upon a dark background which cannot be seen through glasses of complementary colors. A person looking at green-blue letters on a dark ground through a red glass over the sound eye, and a white or green glass over the alleged blind eye, will be unable to see the letters if the allegation is true.

THE GENERAL CARE OF THE EYES AND SCHOOL-HYGIENE.

The care of the eyes in earlier childhood is as equally important as later. From the moment of birth the eyes should be carefully watched.

Ophthalmia neonatorum, a disease appearing between the first and third days of life, and commonly known as "babies' sore eye," is responsible for a large proportion of blindness. The moment the mother or nurse notices the appearance of an inflammation of a child's eyes during the first week of life, a physician should be summoned, and his directions as to repeated cleansing should be rigorously carried out.

Infants' eyes should never be exposed to the direct glare of the sun, either indoors or outdoors. In the crib or bed the baby's face should be turned from the window. When out in its coach it should be protected when lying down by a parasol or awning, preferably lined with some dark-colored material that will not reflect the light. Young children should not be encouraged to play with toys that require close inspection. If blocks, letters, or picture-books are allowed, they should be so large as to be easily seen at some distance from the eye. Even very small infants are better out of doors on a clear day, and when they can walk, they should be romping about in games or looking at distant objects, rather than using their eyes at close range. General physical exercise rather than ocular and intellectual labor is desirable in young children.

As the child grows and associates with playmates or schoolmates every precaution should be used to prevent its infection from granular lids and acute conjunctivitis ("pink eye"), as well as from other contagious diseases. It must not be allowed to use the same towel, handkerchief, or drinking-mug that is used by its companions, and it should especially be restricted from playing with children who have "sore eyes."

The Dangers of the Kindergarten.—There is a very fashionable practice now prevalent of sending very young children, particularly when restless and hard to amuse, to so-called kindergarten schools, where they play with small objects or look at pictures, or sew at close range. This is a distinctly injurious custom. Very young children should be discouraged from all near work, and in day-nurseries and primary schools the most of the teaching requiring visual labor should be by large pictures and charts hung at some distance from the pupils' eyes.

If a child has red eyes, holds its book close, complains of not being able to see at a distance, looks at objects sideways or between partially closed lids, or squints or complains of headache, browache, or pain in the eyes, it is the parents' or teachers' duty to send it to a competent oculist. If the oculist decides that glasses are necessary, they should be put on at once in spite of any foolish prejudices, for they will save and promote the physical and intellectual development of the child and prevent many years of suffering and perhaps irreparable ocular disease.

Young children with defective vision or hearing are often called stupid and inattentive, and actually punished for physical faults which should have been detected and remedied long before.

The question is often asked, "**When shall a child begin school?**" This, of course, depends entirely on the child's health and the condition of the eyes. If the eyes are defective and show a great tendency to astigmatism or myopia, the mental education should be postponed and systematic study should not be started until the person is twelve years of age, when the ocular tissues become more resistant. In the meantime the child should be instructed judiciously at home or in shortened courses at school. Outdoor exercise and properly assigned manual labor should be urged. If the child is of poor parentage and must go to public school, it will be better to postpone the schooling for a few years and enter later a class of children below its age, explaining to teacher the reason of the deficiency in education.

Ordinarily a healthy child with normal eyes may begin school at from eight to ten years of age. It then arrives at systematic study after its ocular tissues are well formed. Of course, if the proper precautions, of which we have much to say later, are practised, the entrance age may be lowered somewhat. No child of tender years should be encouraged in prize competitions; in fact, it would be better if there were no grading in the primary schools other than by term average. The ambitions of parents sometimes lead to ruin of a child's eyes and health.

Care of Children's Eyes at Home.—Continuous close work is most detrimental to the eyes of children. Sometimes parents allow the evils of school-life to be repeated at home. No provision is made for proper lighting and seats. Children are often allowed to read story-books and novels as much as they please, and until late at night in a poorly lighted room or in front of a fireplace, and often in stooping or recumbent positions. All this is wrong. Such children are generally over-ambitious in school, and not only should be compelled to take intervals of rest from close work during the day, but also should be discouraged from using their eyes in reading, writing, or sewing at night. If some home study is necessary, the proper lighting, chairs, and desks should be provided.

The pernicious influence of modern school-life upon the eye as well as upon the general health is not sufficiently recognized by parents and teachers. Nearly all knowledge is acquired to some extent by the use of the eyes, and if the proper hygienic precautions in vision are not heeded, the evil effects of eye-strain upon the whole body may be most serious. With the advance of civilization there is a constant increase of visual defects and of general physical degeneration among school-children. The causes are many. The most prominent are: imperfect construction of school-houses, imperfect lighting, foul air, crowding, poor ventilation, long hours of continuous application at close work in school and necessary extra preparation after school-hours, frequent and trying examinations, and poor print and paper in school-books.

Until recently there has been a disregard on the part of public authorities and educational chiefs of the advice of physicians in matters of public hygiene. Happily this is being overcome through the efforts of the intelligent mass of the community and the patriotic efforts of the physicians themselves, who have often given advice and time willingly and without compensation. We hope soon to see the time when all persons seeking election as school-directors, educational trustees, superintendents of schools, etc., will be subjected to a non-partisan examination or be compelled to show qualification in the principles of school-hygiene.

There should also be salaried **medical inspectors**, controlled by prominent chiefs, to whom they will be responsible for the performance of their duties. These physicians should systematically examine the eyes as well as the general health of every school-child before entrance and during the tender years of school-life. It is essential that the teachers should be instructed in all the elements of school-hygiene.

The Development of Ametropia in School-children.—The eyes of a child at birth are hyperopic and ill-adapted for close work. The ocular tissues are delicate and soft. If excessive near-work is allowed, the pressure of the tense ocular muscles on the eyeball, together with the blood-soaking of tissues from constant or prolonged ciliary congestion, causes the coats of the eyeball to become vitiated and pressed out of shape, and refractive error develops. There is unanimity of opinion in the numerous statistical studies upon this subject.

Most school-children's eyes are defective and generally astigmatic; the hyperopic eyes outnumber the normal and myopic eyes, particularly in early school-life. As the higher grades are entered high myopia and progressive myopia with choroidal disease become more and more numerous, until the proportion of near-sighted eyes in some of the higher continental universities is as high as 50 per cent. Strange to say, in the development of myopia starting primarily in the hyperopic eye, emmetropia is seldom attained, the disease progressing from hyperopia to myopia, as it has been aptly said, "through the turnstile of astigmatism."

In this country the development of myopia has been much lessened by the efforts of oculists to show the intelligent members of the community that much eye-trouble may be offset by regulation of study and reading and the use of proper glasses, with frequent re-examination of all children who show any symptoms of eye-strain. However, there is much to be accomplished in the construction of school-buildings and the regulation of the ocular labor in schools.

School-hygiene.—In view of the importance of eye-strain and ametropia in retarding the intellectual and physical development of children it has been thought advisable to discuss separately each of the more important faults that are found in modern school-systems.

The location of a school-building should be so chosen as to secure the best sanitary environment, if possible on a wide street, remote from any adjacent high buildings, if possible in the center of a lot large enough for a surrounding campus, or playground. It has been found that ocular defects are always more numerous in schools on narrow streets or in close proximity to high walls, and also that children on the lower floors of such school-houses have the worst eyes. It has also been found that there is much less myopia in the primary schools of rural districts.

The light should enter the room directly, and not by indirect reflection from an adjacent wall. The northern light is the most constant. However, the hygienic advantage of having the sun in the rooms during some portion of the day, as is afforded by the other exposures, is not to be overlooked. Excessive sunlight in the warmer months may be controlled by the use of awnings and shades. An oblong room allows better lighting than a square room.

The windows should be numerous and spacious, with large panes of glass, which should be kept clean. They should be so placed that the light may come from the left or from the left and rear of the desks. Light coming from the right produces annoying shadows of the pupils' hands and arms on their books and papers. Light coming from the rear is obstructed by the pupils' backs and also produces shadows. Light from the front is the worst of all, as it may be so dazzling as to greatly embarrass vision. One has only to look at a picture hung between two windows to realize this. Overhead or sky-lighting is an excellent form of securing illumination, but it is only practicable on the top floors. It contributes much annoying heat in warm weather and interferes with proper heating in the winter. Cross-lighting by windows on opposite sides of a room produces very annoying shadows.

There should be at least one square foot of window-space to each four square feet of floor-space. However, there cannot be too much window-space, as excessive light may easily be controlled, while artificial illumination is the only remedy for a deficiency of daylight. It must be remembered that the lower floors require the largest window-space.

The dimensions of an ideal school-room given by Risley, who has carefully studied this subject, are as follows:

	Feet.
Height of ceiling	15
Length of room	32
Width of room	24
Pier or blank wall, rear of room	4
Pier or blank wall, front of room	4
Space allotted to group of windows	24
Window-sill from floor (bevelled)	3
Top of window from floor	14
Height of window	11

This arrangement affords a total capacity of 11,520 cubic feet, or 256 cubic feet for each of forty-five pupils.

The sills should be at least four feet above the floor, so that the light will come over the pupils' heads. Light coming in below is worse than useless, and must sometimes be shaded. There should be no more wall-space above the windows than necessary, and the sills should be bevelled to admit the maximum amount of light.

The window-shades should be of the ordinary Holland style, either light gray, buff, cream, yellow, light blue, or green. There should be two for each window, so that the upper or lower half of the window, or both, may be shaded as desired.

The walls and ceilings of a school-room should be of some light reflecting color, such as advised for the shades. Colors near the red end of the spectrum, such as terra-cotta, absorb too much light to be used. Light-colored woods, such as oak, are preferable to walnut and other dark woods for use in the doors, window-frames, book-cases, etc. There should be as little wall decoration, such as charts and pictures, as possible, and a minimum of blackboards.

A simple test to determine the efficiency of the lighting is to attempt to read small print in the remotest corner of the room on a cloudy day. Artificial lighting should never be needed during school-hours.

The desks and seats should be so arranged in relation to the windows that the light comes from the pupils' left or from the left and behind. Under no circumstances should the desks face the windows. Some arrangement must be made so that the teacher will not confront the direct glare continuously. The desks and seats should be adjustable. It is very wrong to make children of all sizes sit at a uniform-size desk. Let the average size desk be generally used, but for oversized or undersized children the desks should be properly adjusted, and to avoid extra trouble these children should keep the same seats during the entire term.

The common faults are unsuitable shape of back, too great a distance between seat and the desk, disproportion in the height of seat and desk, and incorrect shape and slope of the desk.

The edge of the desk should slightly project over the edge of the seat. The top of the desk should incline downward from the horizontal about ten degrees toward the student, and be low enough to allow the

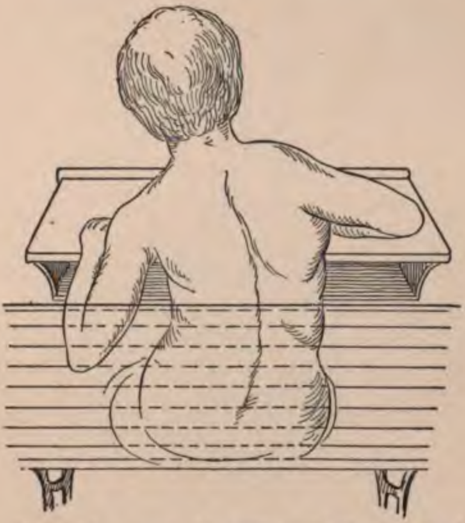

FIG. 58.—Position assumed in writing with the desk too high.

forearm to rest without raising the shoulder. The seat should be sufficiently broad to support almost the whole thigh, and close enough to the floor to allow the sole of the foot to rest on the floor. It should be slightly concave, to prevent slipping, and horizontal rather than inclined. The back should be so curved forward as to support the loins sufficiently and to make it easy and comfortable for even weakly children to sit upright.

If the seat is too high, the child cannot touch the floor, and is uncomfortable and does not get proper aid from the legs and feet to maintain an upright position. If the desk is too high, the elbow can only rest by curving the spine and raising the shoulder (Fig. 58). The work is also brought close to the eyes and causes extra strain. If too low, the child stoops over the desk and becomes round-shouldered (Figs. 59, 60). This position also necessitates great strain on the accommodation and compresses the superficial veins of the neck, leading to ocular and cerebral congestion with its pernicious consequences.

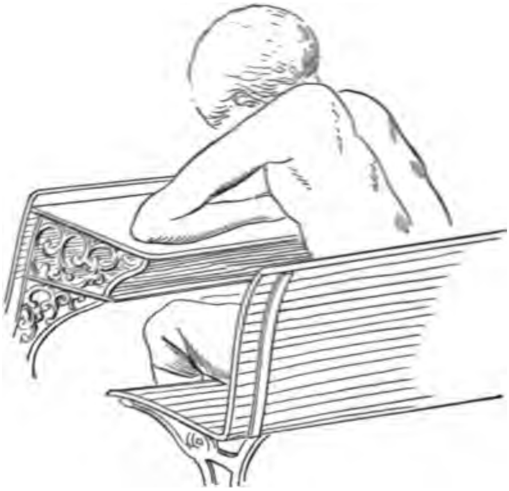

FIG. 59.—Position assumed in writing with the desk too low.

Blackboards, charts, and maps are valuable aids in instructing children, because by them information may be imparted at a distance and the strain of accommodation in near work dispensed with. All figuring or lettering must be sufficiently large to be perfectly legible in any part of the room. Even to those of moderate visual acuity, such characters, to be read at a distance of forty feet, should be at least one

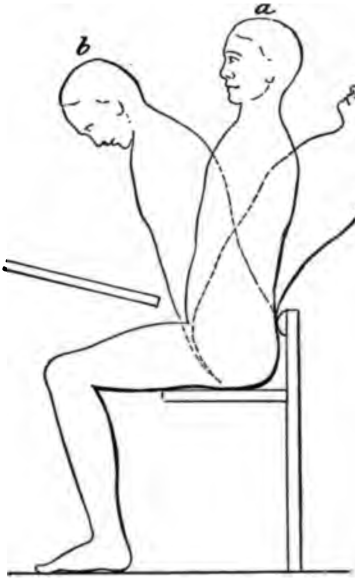

Fig. 60.—Comparative diagram showing the proper position at a desk, *a*; the position when the desk is too low, *b*; and the position when the desk is too high, *c*. (After Cohn.)

and one-half to two inches high. The same precautions should be exercised in writing on the blackboards. If these requisites are observed, then when a pupil fails to see the contents of charts, maps, or blackboards from any part of the room, it is certain that there is a serious error of refraction or disease of the eye requiring immediate medical attention. Blackboards should be kept clean with sponge and water, and as dark and as free from gloss as possible. There is not sufficient contrast of the white chalk on a very dirty grayish-black board, on which only a common eraser has been used. White boards with black crayons, although affording a greater contrast, necessitate soiling of the fingers to such a degree as to be impracticable.

Copying from the blackboard should be avoided as much as possible, as it is very trying to the eyes on account of the constant change of focus from the desk to the board. Blackboards and charts should never be placed between windows, but always opposite the source of light.

Slates are unclean and unhygienic, and often afford too little contrast. Pencils or pen and ink and dull white paper are suitable substitutes.

Regulation of Study.—In the lower grades especially there should be such regulation of the studies that reading or writing after school-hours is unnecessary. The studying should be done in school. The curriculum should be so arranged that wherever possible oral instruction and demonstrations with maps, charts, or blackboards are substituted for study from books. The curriculum of primary schools should be so elastic that pupils in poor health or with defective eyes may be excused from the full course of instruction. Prize competitions or term-examinations should not be allowed in the primary schools. Frequent intervals of rest, such as are afforded by conversations, lectures, and recesses, are very desirable. One daily session of two or three hours is sufficient for the smaller children.

Medical examination of school-children is most desirable. Every child should show a medical certificate of good health and satisfactory vision before being allowed to enter school, and an annual re-examination should be made at the beginning of each term. The teachers may be instructed by the school physicians in the elements of medical examination and in the grosser tests for hearing and vision, and thus become of great assistance to the medical staff. Children with faulty eyes should be sent to an oculist or to an ophthalmic hospital for treatment and for advice as to the advisability of continuing with their studies.

School-books should be small enough to be easily handled, and ought to be printed in easily legible type on dull-surface paper. Cohn insists that in schools all books should be forbidden that contain smaller type than long primer (about 10 point) and a less interval than one-tenth of an inch between the lines. No line should be over four and one-half inches long, nor contain more than sixty letters.

The following remarks apply as well to books and papers other than for use by school-children.

Type.—Heavy-faced type with bold strokes is always the easiest to read. What are known as 8 and 10 point type (each point representing one-seventy-second of an inch) are commonly used in printing. Finer type necessitates great strain on the accommodation, and requires that the page be held too close to the eye. Coarser type increases ocular labor, and often lengthens the columns and lines. The text of this book is printed in small pica type, which is admirably adapted for comfortable reading. Latin letters are infinitely superior to Gothic, and the Germans are fast discarding their trying type in magazines and books for study and scientific reference.

Leading between the lines and **spacing** between the letters are of the greatest importance in securing legibility. There should be about one-tenth of an inch between each line of type. Such a spacing is used on this page. The contrast between leaded and solid type is seen in the following paragraphs in 8-point type:

As a causative factor in the production of headache, eye-strain is by far the most important. Anorexia, dyspepsia, constipation, heart-burn, nausea, repeated attacks of vomiting, etc., represent some of the gastric reflexes. Many cases of obstinate neurasthenia are of ocular origin. Insomnia, nightmare, chorea, and even epilepsy, have often owed their existence and perpetuation to uncorrected eye-strain in some form. The multiformity of the effects of eye-strain can be properly realized only when we understand how vital the function of vision is to every act, emotion, and thought.

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The length of the line is of the greatest importance. The old quarto page should be discarded. No line should extend over four and a half inches; and in large books it is infinitely better to divide the page into two or even three short columns with an appropriate blank space between them. The long lines necessitate extra rotation of the ocular muscles, and are therefore fatiguing to the eye. The lines of this page are about three and a half inches long.

The paper used for reading matter should not be glazed nor have a glaring white surface. A dull surface of some slight neutral tint is preferable. It is, of course, necessary to use a good paper and the best **ink** to secure clear impressions. Paper should be opaque, but this does not necessitate thickness, as some of the most expensive small prayer-books and Bibles are printed on very thin paper. Curved printed surfaces should be avoided.

The greatest offenders in regard to unsuitable paper are the two extremes—the newspapers with coarse paper, indistinct impressions, blurred ink, and small type, and the high-class illustrated magazines and books with a highly finished glossy surface to take the popular half-tone plate impressions.

The style of writing taught is of less importance than the arrangement of the desk and the position of the pupil. So long as the upright position is maintained and both eyes are equidistant from the paper (*i. e.* the paper in a central position) it makes very little difference whether vertical or slanting writing is practised. The pupil may be allowed to evolve his own system of penmanship if the essentials of position are complied with. However, it is contended that vertical writing is much easier taught and is more legible. The belief that it is less likely to cause astigmatism is based on theory.

Overwork of the Eyes.—The eye is one of the most accommodating organs in the human economy, and under favorable auspices will perform an unlimited amount of work; in consequence, persons frequently demand of this delicate organ an amount of labor never expected of the grosser structures. In fact, it is popularly believed that if the eyes are healthy, reading, sewing, and other near work are passive acts, and that the eye is untiring, and never becomes exhausted. This is especially true if glasses have been prescribed, for then the patient is more than likely to blame his oculist if the eyes pain when overworked. Persons whose occupations necessitate much ocular labor should vary their duties with intervals of rest. The clerk who is confined to his desk all day should seek pleasures at night that do not involve ocular labor. In continued reading and sewing, it is well to desist at short intervals and fix the gaze on some distant objects and to close the lids repeatedly. The sensible person so regulates his duties and recreations as to allow his eyes their deserved rest.

Artificial Lighting.—Much of the ocular labor of to-day is performed under artificial illumination. Most persons are so employed during the day that much of their reading, sewing, writing, and other near work is done at night. This is particularly so during the winter months, when the days are short, and there is little inducement to remain out of doors. An "evening at home" generally implies for both adults and children an evening of ocular labor. The amount of eye-work done to-day is greatly in excess of that of our forefathers. The scarcity of books and newspapers and the insufficient means of illumination, often only by the tallow dip or open fire, discouraged the people of the olden time from reading at night. To-day artificial illumination is so perfected, and books, magazines, and newspapers are so abundant and cheap, and circulating libraries are so many, that the habit of reading has grown to enormous proportions.

In view of all these facts the study of artificial lighting becomes a matter of great interest and importance. The main sources of artificial illumination are kerosene, gas, and electricity, all of which when properly employed may be satisfactory. The nearest approach to perfect illumination is that light which most nearly resembles diffuse daylight. Such diffused lighting by artificial means has not been practicable in dwellings, and the best that is generally done is to afford several sources of light near which different members of a family may read with equal ease.

The principal questions of importance in artificial illumination are the quantity and quality of the light, its steadiness, the vitiation of the atmosphere by the products of combustion, and the expense.

The proper installation of lights in dwellings, school-rooms, stores, and workshops is a matter often neglected. It is common to see a large family gathered about a single gas-burner so placed that those most remote from the light do not get nearly enough illumination. This condition is remedied in ordinary dwellings by having as many sources of light as are necessary to allow each reader sufficient illumination without annoying any of the others. In assembly rooms, stores, workshops, etc. these difficulties are not so easily corrected.

Besides the expense and necessary vitiation of the atmosphere, the proper arrangement of the lights is often very troublesome. Sometimes the light may be distributed from overhead by reflectors, which also may act as ventilators. In ordinary cluster illumination, even distribution is impossible. Those nearest the light receive the most illumination, but suffer from radiation of heat, and in many portions of the room annoying shadows are cast. If in addition to the central cluster extra lights are used, these may aggravate the annoyances and in some cases shine directly into the eyes of some of the occupants of the room. If, for instance, charts or blackboards are especially illuminated by extra unshaded lights, the writing thereon is read only with the greatest difficulty. In illumination from both sides by single flames, persons who receive light from the right are annoyed by shadows of the hand and head. If the light is only from the left, then some of the occupants of the room will be annoyed by shadows cast by their own bodies, and those remote from the sources of illumination will receive too little light, and if the amount of illumination is raised to prevent this, those nearest will be dazzled by the increased light. Illumination by individual shaded lights for each occupant of the room may be used, but this entails great expense, and unless incandescent electric lamps are used there is too much heat given off and the vitiation of the atmosphere is very great.

Indirect illumination, by throwing part of the light on suitably colored walls and ceilings from which it is reflected diffusely over the lower part of the room, has been used with success both in this country and abroad, and deserves more attention than has been accorded to it by architects and builders.

The different illuminants will be discussed separately in a general way rather than by technical photometric study.

Kerosene is the principal illuminant of rural communities and among the middle and lower classes. Its cheapness is a great point in its favor. The brilliant light of the modern lamp when properly shaded by a slightly bluish chimney or shade to absorb an excess of yellow rays is very satisfactory, and, in fact, is preferred by many students and other literary workers to all other kinds of illumination. The principal objections are the heat, the trouble in filling and keeping clean, the danger of explosion and fire if upset, the odor, and the great vitiation of the atmosphere. One, two or three persons working in a large, well-ventilated room may be very comfortable with a coal-oil lamp, but in a large assembly-room in which many lamps are necessary and some are always smoking, vitiation of the atmosphere is great.

Illuminating-gas has been a great convenience, but also the ruination of many eyes. As usually furnished in cities, it has a great excess of yellow rays, which are very injurious. The flame of the old-fashioned "fish-tail" burner, blown by every current of air so as to be continually flickering, is a most pernicious form of lighting; yet for years many families have read at night by this means. The vitiation of the atmosphere is very considerable in gas-combustion, and coal-gas is dangerous and more expensive than kerosene, but not so hot and much more convenient. The principal improvements in gas-lighting are the Argand burner and the Bunsen burner, heating a patented composition-mantle to incandescence.

The Argand burner is very easily controlled, and gives an excellent light, especially when properly shaded. It, however, lacks intensity and is very hot.

The incandescent mantle is without doubt the greatest improvement in gas-lighting. It gives a white light resembling daylight, and, under proper adjustment and regulation, of far greater volume (50–70 candle-power) than any other gas burner, is not so hot, and does not consume as much gas, and hence does not cause such vitiation of the atmosphere. The expense of installation is more than offset by the saving in gas. It is too intensely brilliant to be placed on a level with the eye, unless it is shaded with ground glass, opaque glass, porcelain, or other like material of a neutral tint. If it is desired to light a whole room, the burner should be suspended quite high, and should be unshaded beneath. Holophane globes or reflectors will aid in deflecting most of the rays downward.

Electricity is undoubtedly the coming means of artificial illumination.

The arc light is unsurpassed for lighting large areas. It is almost colorless, and its spectrum most nearly resembles that of sunlight. It is easily controlled, and is becoming more and more inexpensive. Almost any candle-power up to 1000 may be obtained. The arc light is, of course, too dazzling and irregular for ordinary interior lighting, unless very much modified by shading.

The incandescent light is now in general use in the cities of this country, and many of the suburban towns have their own electric light plants. It is being furnished cheaper each year, and on account of convenience it is deservedly a most popular form of illumination. It is controlled and lighted very readily, and is virtually as portable as a candle and may be used for decorative purposes. It gives a maximum amount of light with a minimum of heat, and this without vitiation of the atmosphere—a most important advantage. The ordinary incandescent light is called 16 candle-power; but in practice its illuminating power falls to between 12 and 14 candle-power. This is sufficient only for individual purposes, but the amount of light desired may readily be multiplied to large proportions by the installation of extra lights. The annoying glare of the incandescent coil may be remedied by an opalescent shade.

Comparison of the different illuminating agents is given in the following table, taken from the *London Journal of Gas-lighting*, January 18, 1898:

Illuminating agent.	Burner or lamp.	Illuminating power (in practical use).	Consumption of illuminating agent per hour.	Heat expended.	Cost per burning hour.
		Candles.	Cu. ft.	Calories	Pence (= 2 cents).
Coal-gas.	Flat flame.	30	14.09	1995	0.768
"	Argand.	20	7.06	1000	0.384
"	Regenerative.	111	14.41	2042	0.780
"	Incandescent.	50	3.53	500	0.192
Spirit.	"	30	3.48 cu. in.	318	0.240
Petroleum.	1⅛ " burner	30	6.57 cu. in.	960	0.264
"	Incandescent.	40	3.05 cu. in.	550	0.120
Acetylene.	. . . .	60	1.27 cu. ft.	534	0.264
Electricity.	Incandescent.	16	48 Watts	41.4	0.348
"	Arc.	600	258 Watts	222	1.860

Acetylene produces a brilliant and in fact dazzling white light, and on account of the small amount consumed it is not expensive and there is a small amount of effete materials of combustion. It is, however, very dangerous and liable to explode, and is chiefly used in bicycle and carriage lamps. The danger of explosion begins when the mixture of acetylene with air is at the proportion of 1 to 26, and it ends at 1 to 4.

Prismatic Devices.—In older school-houses that for financial reasons cannot be abandoned, and in office- and store-buildings where land is so valuable that the buildings must be high and contain many inside rooms insufficiently lighted, the problem of lighting is a perplexing one. The disadvantages of using the eyes continually in an artificial light, the heat and vitiation of the atmosphere, and the expense have all been considered, and need no further discussion here. Any plan that will avoid or that will even partly overcome these difficulties should be earnestly advocated.

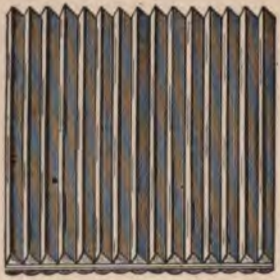

FIG. 61.—A plate of glass prisms.

Within the last few years several manufacturers have placed on the market plates of glass which are so constructed that they contain a combination of prisms (Fig. 61) which will bend rays of light from overhead and diffuse them at any angle. Sometimes curved surfaces are incorporated with the prisms. By these prismatic plates the insufficient perpendicular light of a deep light-well or of a narrow street lined with high buildings may be so refracted that it may be used to illuminate the darkest inte-

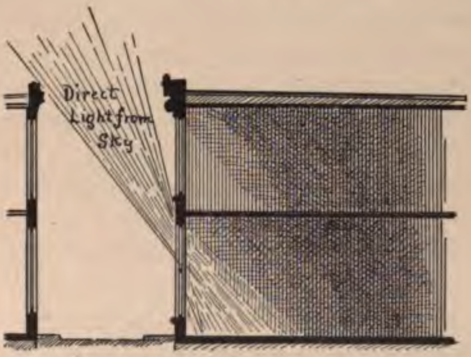

FIG. 62.—An improperly lighted room on a narrow street.

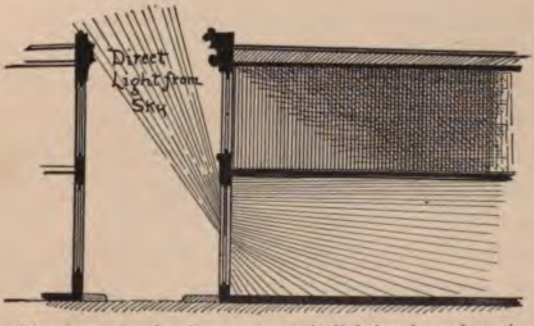

FIG. 63.—The same showing improvement in lighting by prismatic devices.

riors (Figs. 62 and 63). The prisms may be inserted in ornamental window panes or placed in the form of canopies inclined a few degrees from the vertical; or in cases of cellars and basements they may be used in the form of mosaic tiling and be assisted by a second interior screen. These prisms are inexpensive and ornamental, and are soon paid for in the saving of gas or electricity, besides furnishing illumination infinitely more healthful to vision. A similar arrangement of prisms is also utilized in glass globes, called **holophanes**, for gas, oil, or incandescent lights suspended overhead. These globes deflect most of the rays of light downward.

The necessary hygienic precautions in reading include the selection when possible of large type, sufficiently spaced, unglazed paper, and short columns. These requisites, of course, do not apply to cheap newspapers, but may be enforced in magazines and books. Sufficient illumination is equally necessary, and of no less importance is the position of the reader, the position of the book, and the relation to the source of the illumination. The position of the reader should always be upright, leaning slightly backward, with the head erect, and the book held nearly on a level with the eyes, or if it is a heavy volume it may be set in a portable and adjustable book-rest or placed on a table or desk in such position that the top and bottom of the page will be equidistant from the eye. The closer objects are held to the eye the more muscular and accommodative strain is necessitated in near work. Unfortunately, the common tendency is to read and sew at close range, even when not necessary for clear vision.

The proper reading distance is about fourteen inches from the eye; but no type should be used that is not clearly legible at twenty inches. Highly near-sighted persons often hold their reading-matter very close to the eye, and, while reading at their far-point without the aid of accommodation, to secure binocular vision they put such tension on their muscles of convergence that serious results may follow. Fatigue of the ocular muscles often produces as uncomfortable symptoms as uncorrected ametropia.

The head should be held erect in reading because in this position there is less liability to ocular congestion.

The book should be held nearly on a level with the eyes. Continued downward rotation of the eyes is very fatiguing, and there is an inclination to stoop the shoulders before many minutes. Ultimately round-shoulders and contracted chest are produced.

The light should be on a level with the top of the head or above the head, and should illuminate over the left shoulder. When several persons are seated around a table or a long desk, and by unalterable architectural reasons all cannot secure the most advantageous position in relation to the light, the use of **eye-shades** is often of great help.

Reading in a recumbent position is a pernicious habit, and is particularly dangerous during convalescence from illness or when physically tired. If there is fatigue or a tendency to drowsiness all close work should be suspended, for in this condition accommodation and convergence are only effected by continual exercise of will-power, and much nervous energy is lost. When a person is tired or drowsy there is a constant tendency for accommodation and convergence to relax; instead of these acts being automatic, there is distinct consciousness of an effort to maintain them. In fact, when one is distinctly sleepy, instead of the normal muscle-balance, there is sometimes actual divergence.

In the recumbent position there is extraordinary strain on the muscles of downward rotation, besides a difficulty in adjusting the book for proper illumination. Again, the head is often so bent as to encourage ocular congestion. If one must read in the recumbent position, the book should be placed against a pillow where it will be well illuminated, and the reader should lie on the side with his face opposite to the page at a comfortable reading distance.

Constant looking upward is quite as fatiguing as reading in the recumbent position, as any one will bear witness who has gazed for a long time at the paintings in some of the large Continental art galleries. There is a peculiar affection of the ocular muscles, known as "**miners' nystagmus,**" which is caused by the constant upward gaze while at work in the supine position in coal-mines. In this condition the stability of the ocular muscles is impaired, and there is constant oscillation of the eyes.

Reading in cars or carriages is injurious to the eyes. Because of the constant jolting, the distance between the type and eye is continually changing, necessitating frequent and abrupt accommodative adjustments. Besides this fault, there is often very poor illumination in the conveyances. However, at the present day the better class of railroads have improved these conditions; there is sufficient lighting, and by making better roadbeds and furnishing better balanced cars with more numerous springs, they have reduced the jolting to a minimum. In some of the modern cars with incandescent lights for each section, reading is not at all uncomfortable. If reading in jolting cars is absolutely necessary, it is a good plan to use a card to be placed under each line, moving it down the page as the reading progresses.

Sewing and embroidery require the most trying ocular labor and the best conditions of illumination. When possible, all such work should be avoided at night, and working on black goods by artificial light should be absolutely forbidden.

Engravers need not be told the necessity of bright daylight, as they soon find any other illumination incompatible with fine workmanship. They often need enlightenment, however, on the necessity of resting their eyes at frequent intervals during their working-hours. All persons doing fine eye-work should be accurately fitted with glasses if they are at all ametropic.

The habit of wearing veils is likely responsible for some deterioration of vision, particularly if they are very thick or dotted. These articles are often necessary to protect the face, to keep the hair smooth, or to maintain headgear in position. In such cases, a thin veil with a very large mesh will answer all these purposes without interfering with vision.

The effects of smoking and drinking on the eyes are often exaggerated. Of course, if there is such excess practised that the whole system is affected, the eyes will participate in the resultant morbid processes.

Again, in some persons there is a special idiosyncrasy to alcohol and tobacco, and often in cases of partial blindness apparently due to what is known as **toxic amblyopia**, the amounts of tobacco and stimulants used have not been large, yet when these substances have been discontinued vision has been restored. Such patients should, of course, give up forever both habits. A particular danger of tobacco-smoke is its irritating action on the conjunctiva, particularly when the smoking is done indoors while reading. The smoke curls about the face and enters the eyes, causing great irritation and blurring of vision.

Relation of the Eyes to the General Health.—It is a great mistake to consider the visual apparatus as a separate organization. It is intimately connected with the whole human economy. If there is a deficient blood-supply or nervous exhaustion or perversion, if the secretions are abnormal, in fact, if there is any serious functional or organic change in the body, the eyes may participate in the evil consequences; and in the same way visual defects may influence the whole constitution. Those measures and modes of life which are conducive to general health and vigor will be beneficial in maintaining ocular health and vitality. Persons who seek to preserve their vision all through life must not only observe the laws of ocular hygiene, but also those of general physical and mental hygiene, such as are set forth in the other chapters of this book.

SPECTACLES AND EYE-GLASSES.

The invention of spectacles has been attributed to two Italians, Alexander da Spina and his contemporary, Salvinus Armatus, and to Roger Bacon, all of whom lived in the thirteenth century. On the tombstone of Armatus is said to be inscribed, "The Inventor of Spectacles." From other sources it is contended that spectacles were introduced into Europe through the works of Alhazan, a Saracen, who died in 1038 A. D. It is thought, however, that both concave and convex lenses were used by the Chinese long before this. Seneca and Pliny seem to be familiar with some of the properties of lenses, and there is a legend that Emperor Nero was near-sighted and used a concave precious stone (emerald) to assist his distant vision. It is, however, only in the latter half of the nineteenth century that the wearing of glasses has become universal, and that the various mechanical improvements leading up to the present high standard of excellence have been made. Fitting glasses upon scientific principles was never at all generally adopted until the labors of Donders and Snellen had evolved a rational method of examining defective eyes and prescribing correcting lenses. Before their time all this was largely a matter of guess-work, often left to spectacle-vendors; and simple convex and concave spherical lenses with large increments of strength were used. Cylinders were not made.

The province of the optician is solely to grind and fit glasses. There is a class of persons calling themselves "scientific opticians," "refracting opticians," "ophthalmists," and the like, who, without even serving the apprenticeship of a skilled optician, without the slightest medical training, and with very little or no mechanical knowlege, undertake to prescribe glasses as well as to sell them. They advertise "eyes examined free," and sometimes rapidly travel from town to town calling themselves "doctor" or "professor." It is hardly necessary to reiterate that it is dangerous to intrust the care of such delicate and intricate organs as the eyes to a non-medical person who, working without a fee, has only an interest in the sale of glasses, which, whether needed or not, proper or improper, may be urged on the unsuspecting patient. In no case is an optician the proper person to prescribe glasses. This is the business of the oculist, who is an educated physician, and has had long experience in medical colleges, clinics, and hospitals, and who is devoting his life to the study of his profession. He alone is capable of comprehending the influence of the general systemic condition on the eyes, and of defective eyes on constitutional disturbances. Often glasses are prescribed for definite therapeutic purposes other than improvement in vision. The optician is unacquainted with the minute anatomy and physiology of the eye and its physical and psychical relations with the whole organism. He is not skilled in the broad science of medicine, of which ophthalmology is only a small part.

The true optician has no pretensions other than the skilful grinding and adjustment of lenses. To be a competent workman he also devotes his life in constant endeavor to improve the mechanical construction of his products, making eye-glasses and spectacles more sightly and comfortable. Too great stress cannot be laid on the importance of a good optician. The results of all the careful work of an oculist may be set aside by careless and incompetent manufacture and fitting of glasses. It is a safe rule to patronize only those opticians who do not attempt to examine eyes, but confine themselves strictly to grinding and fitting glasses—in other words, purely "prescription specialists." Such men may charge more for their material and work than the prices advertised by "refracting opticians," but the worth is in the construction and fitting, and such articles will be cheaper ultimately. Besides, the patient who is ignorant of the proper charge need not fear imposition, such as is often practised by "refracting opticians." Reliable opticians are sustained only by the recommendation of prominent oculists, and must act honorably or their support will soon be withdrawn.

As a general rule, spectacles are preferable to eye-glasses, and should be used when there is much astigmatism, or when the nose is not properly shaped for the correct adjustment of eye-glasses. The objections urged against spectacles are based on esthetic grounds and upon the uncomfortable pressure they may make on the nose and behind the ears. A well-fitted pair of gold frameless spectacles is infinitely neater looking than eye-glasses pulled out of shape by a cord or chain hanging over the ears and face. If heavy frames are ordered and the spectacles hurt the ears or nose, they are not fitted properly, and the optician should be consulted immediately.

Spectacle-lenses are made of clear flint or crown glass. There is no therapeutic virtue or extra durability in the so-called and much advertised "pebble glasses," "rock-crystal glasses," etc. All respectable opticians use for the purpose of grinding lenses the best glass that they can buy. The cost of the glass is small, and they could not afford to waste skilled and valuable labor on poor material.

Spectacle-frames are made of gold, steel, silver, and aluminum. The best and most serviceable material is 14-karat gold. It has superior qualities of temper, adaptability to shaping, and durability, and should be used when possible. Ultimately 14-karat gold frames will prove the cheapest, but when they are not practicable on account of expense, the next choice is 10-karat gold or steel. Although steel may rust, it is preferable to silver or aluminum on account of its superior hardness and temper. Rubber and shell are light, but too brittle for use in spectacle-frames.

Contrary to popular idea, within certain limits, the heavier the bridge and temple-pieces of spectacles the more comfortable they are. Heavy temples are rigid and keep their shape better, as they stay on the face by their weight, and fit the face, nose, and ears. Such frames do not cut the ears or groove the nose, whereas light-weight frames have no rigidity, cannot be properly shaped, and maintain their position by pulling from the nose to the ears, which is not only annoying, but necessitates constant adjustment. The ideal frames are what are known in the trade as 798½ (rimless) and 718½ (rimmed) 14-karat gold spectacles.

Fitting of Spectacles.—It is important that the **bridge or nose-piece** should be in accurate apposition to the nose, but not deeply indenting it. It should be round on cross section, rather than flat or triangular with sharp edges. In subsequent adjustment the original fitting of the bridge should never be disturbed.

The temple-pieces, or "bows," should be curved to set behind the ears for constant wear, but may be straight when the spectacles are used only for close work. They should extend in a direct line from the hinges on the outer lens-attachment to the top of the ears. The curve at the top of the ear should be sharp, and the temple-pieces should conform to the shape of

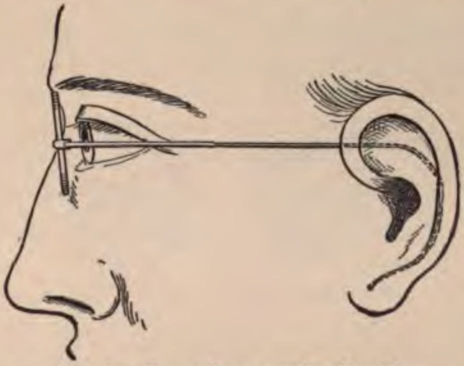

FIG. 64.—Spectacles properly adjusted.

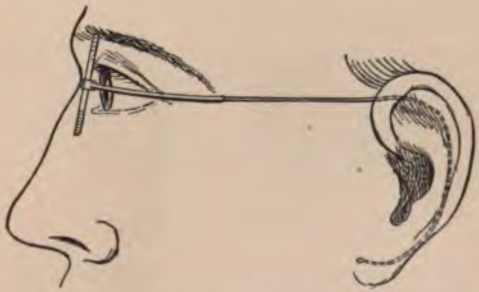

FIG. 65.—Improperly fitted spectacles.

the back of the ear (Fig. 64). The typical careless fitting is shown in Fig. 65. The bows should be shaped to the face and in accurate apposition, but not grooving the skin of the temple, thus preventing movement in walking, running, etc.

The lenses must be of such size and shape that the wearer does not see over or under them, and they must be properly centered and be at equal distance from the eyes (Fig. 66). Improper centering and unequal distance from the eyes (Fig. 67) often produce prismatic and other effects so injurious as to offset any optic assistance afforded by the glasses, and particularly is this the case in high-power lenses. Lenses should be ground dull on the edges. Polished edges not only cause annoying reflections, but are much more conspicuous.

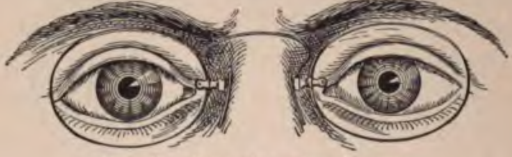

FIG. 66.—Properly centered lenses.

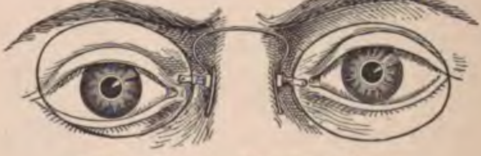

FIG. 67.—Improperly centered lenses.

Position of Spectacles.—The upper edges of the lenses should be slightly inclined forward, as most of the time the eyes are directed downward, and in the inclined position the axis of vision will strike the surface of the lens at a right angle, and so avoid reflection. In glasses for near work only the inclination may be made greater.

To secure the proper optic assistance from lenses, they should be worn as close to the eyes as possible, and in cases in which very strong lenses are worn any interfering eyelashes may be trimmed at short intervals without noticeably altering their growth or texture.

Concave lenses diminish in refractive power as they are moved from the eye, while the reverse is true of convex lenses. This explains why old persons who have worn the same pair of convex lenses for reading during many years, gradually push them further and further away from the eyes.

Care of Spectacles.—In taking off spectacles both hands should be used in such a way that the temple-pieces are not pulled widely apart, or otherwise strained so as to wrench, bend, or loosen the attachments. Some persons simply pull their spectacles over the ears and weaken the tension and destroy the shape of the bows. In putting on spectacles, the lenses should not be crushed against the eyelashes and soiled. The bridge should be placed one-third down the nose, grasping the temple-pieces near the ear-curve between the thumb and first two fingers. The ear-curve should then be bent over the top of the ears without dragging the lenses any closer to the eyes; the frame should be pushed into position, and, lastly, the temple-pieces should be pressed down upon the tops of the ears.

Spectacles should be folded as little as possible, to keep the hinges and attachments stiff. Instead of putting them in a case at night on retiring, they should be left unfolded and resting on the edges of the lenses upon a shelf, mantle, bureau, or some other article of furniture. Lenses should never be laid on their face, but always on edge. If cleansed with improper material or placed face down they are liable to become soiled or scratched. Should the latter occur, the only remedy is repolishing or renewal. Glasses not perfectly clear and clean not only interfere with vision, but also cause unnecessary strain and irritation.

Lenses should be cleansed several times daily. For this purpose a clean unstarched cotton or linen handkerchief may be used. Chamois, leather, tissue paper, silk, or woollen material, etc., may scratch the surfaces. To remove all obscurities (except in bifocal glasses) the lenses may be cleansed with ammoniated water once or twice daily. In cleansing, the frame should be firmly grasped at the outer edge, close up to the lens, near the hinge, with the thumb and forefinger of the left hand, and not by the bridge. The frame of the lens being cleaned, and not the opposite one, should be held. In cleaning rimless eye-glasses, great care must be exercised not to bend or change the tension of the spring.

Reading-spectacles, which are to be put on and taken off constantly, are sometimes more conveniently made with straight temple-pieces, particularly in women, on account of the abundance of hair about the temples. Children and persons engaged in occupations in which the lenses may be exposed to violence should wear spectacles with rims.

Eye-glasses, or "pince-nez," may be used by adults when the lenses are not too heavy or when there is little or no astigmatism, provided the bridge and sides of nose are adapted for them. The new highly-tempered and thin spring, and the modern nose-piece or guards with adjustable arms or offsets permit many more persons to be accurately fitted in eye-glasses than previously. But even when properly fitted, eye-glasses may not be put on in the same position or place twice in succession, and they are easily bent, losing their exact position before the eye, which by changing the axis of a cylindric lens, particularly in high astigmatism, may greatly lessen the optical improvement. The oculist may have fitted the glasses accurately after the most careful tests, and yet have his results unsatisfactory on account of the foolish pride of a patient who insists on wearing eye-glasses when spectacles alone will give relief. Eye-glasses are more conveniently carried about, and need not be folded in a case and may be hung on a hook on the vest or waist. They may have rims or not, according to the liability to breakage or to the taste of the wearer.

Bifocal Lenses.—Persons past middle life with defective eyes require a separate pair of glasses both for reading and for distance. The reading lenses cause a blurring of vision at a distance, while the distance lenses are insufficient for reading, and the greater the age the greater is the difference between the lenses for far and near vision. In such cases, instead of two pairs of glasses to be changed according to the visual needs, bifocal lenses may be used (Fig. 68). The improved form, with a reduced additional convex segment, cemented on the distance lens, is far more satisfactory than the old split Franklin bifocals. The lower segment should be about seven-eighths of an inch wide and one-half inch high; the upper edge more curved than the lower. If the occupation of the patient subjects him to high degrees of heat or steam, the lower segment should be inserted into a groove in the bottom of the distance lens and placed in rimmed spectacles or eye-glasses instead of being cemented on with Canada balsam. The two lenses may also be ground on one piece of glass; but this form of bifocals is more expensive.

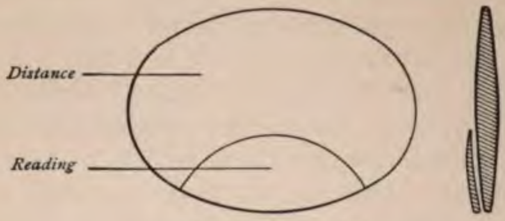

FIG. 68.—Bifocal lens.

There is much foolish prejudice against wearing bifocal lenses. Although it requires some little time to become accustomed to them, bifocal glasses ultimately give far greater satisfaction, and are more convenient than two different pairs of glasses. The patients must be warned about the danger of making a mistake in going up or down the stairs, getting on and off cars, etc., until they have become accustomed to the prismatic displacement occasioned.

Bifocal lenses need the greatest care to keep them from getting out of adjustment. More than others they demand absolute precision of position. Any imperfection in the cementing of bifocal segments should be remedied at once. The Canada balsam used is sometimes disturbed by the heat and moisture of the face, and becomes opalescent, interfering with vision. If this occurs, the lenses should at once be returned to the optician for repairing.

Trifocals have been used by bookkeepers, musicians, and other persons who are compelled to use their eyes alternately at the reading distance and at a distance just beyond, as in copying, reading music, etc. Such lenses must be too large to be comfortable, and then are unsatisfactory. It is better to have a separate pair of bookkeepers' or musicians' glasses adapted to a focus of from twenty to twenty-five inches.

Pantoscopic spectacles is the name sometimes given to those in which only one-half of a lens is used, allowing the wearer to look over them at distant objects. They are convenient for persons who need only a reading-glass, or they may be employed as hook fronts over distance lenses (Fig. 69).

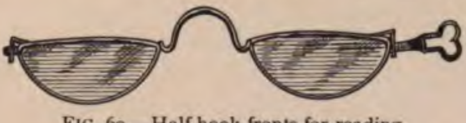

FIG. 69.—Half-hook fronts for reading.

After cataract-extraction or for persons with one eye **reversible frames** may be used, the lens in one side being used for distance vision, while that on the other is employed in reading. However, a bifocal lens is preferable in such cases.

Lorgnettes (lorgnons) and **monocles** may be used occasionally, but should not be employed constantly as substitutes for spectacles or eye-glasses. The same optic correction necessary in the distance spectacles or eye-glasses must be used in the lorgnette, and the lenses should only be fitted by an oculist. There is a foolish idea that a telescopic or magnifying lens producing an effect somewhat like opera-glasses may be inserted in a lorgnette. Such optic aid cannot be obtained without a dioptric system of at least two lenses. Although persons with nearly normal vision may think at first glance that they see better with a low-power concave lens, the use of such correction when not indicated by myopia causes extra eye-strain. A person with perfect eyes will derive no advantage at distance with a lens in lorgnettes, and persons with faulty vision cannot be made to see better with lorgnette lenses than with their proper correction worn in spectacles or eye-glasses.

Lorgnettes are also used by elderly women for carrying reading-glasses, and bifocal glasses are also used in this manner on the street, in church, at the opera, etc. If the patient has very much astigmatism or needs a high-power lens, the lorgnettes must be carefully fitted and the lenses accurately centered, and they should always be held exactly before the center of the pupils and in a straight position.

Tinted glasses should seldom be ordered for constant use, but may be temporarily prescribed in inflammatory conditions, during mydriasis, for use at the seashore, etc. The habit of wearing tinted glasses is difficult to overcome. Persistent dread of light (**photophobia**) is usually due to uncorrected or improperly corrected ametropia. It is a well-known fact that the constant use of tinted glasses is most employed in countries where the importance of correcting eye-strain even in comparatively low defects is not recognized. When tinted glasses are indicated, London-smoke plane lenses should be used, and if necessary worn over the ordinary spectacles or eye-glasses and taken off indoors, rather than to have the correction ground in smoked glasses. Coquilles should be avoided, as they generally have some spheric or cylindric effect on an irregular surface. Blue, green, or any other colored glasses should never be used when plain smoked glasses are obtainable.

Before leaving the oculist's care the patient should return with the glasses for examination of the adjustment and verification of the lenses by neutralization. Both spectacles and eye-glasses may feel uncomfortable for the first few days. Tender skin may be bathed with witch-hazel, and hardened by applications of alcohol, cologne-water, alum-water, etc. Frequent visits to the optician for readjustment are necessary, and for this service the best opticians make no charge to their regular customers. Glasses should never be worn when decentered or otherwise out of shape. The good effects of many careful examinations of refraction have been spoiled by maladjusted and decentered lenses.

The prejudice against wearing glasses is happily diminishing and disappearing in most American communities. Carefully prescribed and correctly adjusted lenses constitute one of the greatest boons to humanity, and when they are needed nothing else will take their place. Headaches and other asthenopic symptoms will continue until the necessary optic correction is worn. It is not uncommon to see people, who have been advised of the necessity of wearing glasses, dose themselves with headache-powders, antibilious pills, nerve-tonics, etc. *ad nauseam*, rather than accept the proper means of relief. Generally this is due to vanity of personal appearance ; but occasionally it arises from the belief that oculists invariably put glasses on all their patients, or that if one starts to wear glasses the eyes will be so weakened that he will never be able to leave off wearing them.

Explanation of the frequency with which glasses are worn in the present day is often asked of physicians and oculists. The chief reason is doubtless the excessive demand of modern life on the eyes. Schools, newspapers, magazines, books, and free libraries have greatly multiplied in the last few decades. Artificial illumination has been so perfected that every encouragement is offered for reading, sewing, and other near work at night. Another reason is that formerly the importance of eye-strain in causing inflamed lids, habitual headache, and other more remote reflexes was not recognized. Then the advice of an oculist was sought only when vision was defective, while to-day a large number of an oculist's patients are slightly far-sighted or astigmatic and have excellent vision, but complain of reflex asthenopic symptoms, the most common of which is headache. Again, much of the modern science of ophthalmology and the refinements in the grinding of lenses and fitting of spectacles and eye-glasses by opticians are of very recent development. The final reason, and not the least important, is that an ancient senseless prejudice has been permanently overcome. When glasses are indicated they are almost as necessary as proper rest, and the longer they are withheld the more serious will be the consequence. As to the frequent inability to discontinue their use later, if this is the case, no better proof of the wisdom of prescribing them can be offered. On the other hand, it not infrequently happens that by tiding over a threatened nervous breakdown during a temporary state of ill-health, the use of glasses allows the system to recuperate to such a point that they may then be discarded, when otherwise either the health might have been irreparably ruined or the ultimate resort to glasses become permanent.

The proper glasses do not always suit at first, and the oculist is often called upon for an explanation. In far-sightedness and astigmatism the accommodation is so hypertrophied and cramped by long years of strain that the full correction found under mydriasis is rejected when the effects of the drops pass off. In such cases the proper lenses may blur distant vision, and the patient may even see much better at a distance without them. However, the glasses should be persisted with, in the same manner that a disagreeable medical treatment is pursued, until the accommodation relaxes, when all the objections disappear and the asthenopic symptoms are relieved.

If patients succumb to their early difficulties with glasses and only wear them spasmodically, the initial discomfort is only prolonged. If the glasses become absolutely unbearable, the oculist's advice should be sought before they are discarded. The spasm of accommodation is only one of many reasons for the discomfort of new lenses. Often the apparent change in the size of objects and the false estimation of distance are sources of perplexity; but these also disappear in a few days. In such cases it is common to hear such complaints as "the glasses make me dizzy," "everything seems crooked," "the floor seems too close to me," "the glasses make me nervous," etc.

The reflections from the glass and the irritation by contact with the skin are other troubles which soon disappear. Again, persons who have never worn glasses will turn their eyes instead of slightly turning their heads when looking sideways and so bring about confusion of vision. Some patients, during their early period of annoyance, happening to pick up a pair of weaker convex or stronger concave glasses, as the case may be, belonging to an acquaintance, and, finding that for the moment vision appears plainer, may foolishly believe that their oculist has given them the wrong optic correction. It is by reason of this same false momentary judgment in trying lenses without the use of mydriatics that patients who select glasses in an optician's store are so often given a wrong correction.

Finally, certain near-sighted adults who have never worn a distant correction, although acknowledging the visual improvement afforded by the proper glasses, yet have become so contented with the general haze before their eyes, and are able to read so easily with their naked eyes, that they refuse to use glasses constantly, although employing lorgnettes and eye-glasses occasionally at the theatre, etc. Such persons should be informed of the danger of progressive myopia when the proper lenses are not worn, particularly in prolonged close work (see page 214).

Glasses should be changed at frequent intervals, particularly for children or adults who are rapidly changing in stature. A great difference in refraction may occur after profound shock, protracted illness, confinement, and other similar depressing conditions. A good rule to follow is to seek the advice of an oculist whenever any of the original asthenopic symptoms recur or when there is disturbance of either far or near vision; and in the absence of any subjective indications of change, it is not an unwise procedure to consult an oculist at least every three years, and so forestall any disagreeable symptoms. The necessity of changing glasses to correct the constantly changing refraction is not generally known, and it is not uncommon to find educated persons wearing one pair of glasses for many years, and often aged persons use the same reading-glasses over long periods, gradually pushing them down the nose as the presbyopia increases.

Artificial Eyes.—In persons so unfortunate as to lose an eye or who have had enucleation performed on account of disfigurement, an artificial eye offers a good substitute and is often a decided cosmetic advantage. Artificial eyes are made of every size and variety. The requisites in selection are the proper color of the whitish-blue sclera, which differs in shade from that in the pale blonde to the dark brunette, the color of the iris, and the normal size of the pupil. Artificial eyes are generally made of porcelain and are mere shells, although recently hollow glass and metal bulbs have been used to fill out the orbit. The amount of tissue and muscle left in an orbit after enucleation of an eyeball determines the motility of the stump. In some orbits there is such free movement of the stump over which the shell fits that it follows exactly the ordinary movements of the sound eye and is only discoverable in positions of extreme rotation. This is particularly the case when abscission, evisceration, implantation, or Mules's operation has been practised.

An artificial eye may be first worn after a lapse of two or three weeks from the date of operation if all inflammation has subsided. Early application of an artificial eye is advisable to prevent absorption of orbital fat. The orbit is very tolerant of foreign bodies. However, to accustom the tissues thoroughly to an artificial eye, it should not be worn more than a few hours at a time for the first few days.

To insert an artificial eye, it is lubricated and the broad outer end slipped under the upper lid, which is slightly raised; the lower lid is then drawn downward and the patient is told to look down, when the eye is gently manipulated into place. Irritation of the stump by an artificial eye has led to sympathetic involvement of its fellow, and must be guarded against. An artificial eye should be taken out at night and washed, and placed where it will not undergo a marked change of temperature. It must be replaced every two or three years, as it loses its luster and becomes noticeably different from the sound organ.

HYGIENE OF THE BRAIN AND NERVOUS SYSTEM.

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GENERAL PRINCIPLES.

Nervous tissue is one of the most delicate and highly organized in the body, and possesses the least reparative power. On this account Nature has provided it, for the most part, with appropriate bony protection—the cranium in the case of the brain, and the spinal column in that of the cord—against external violence. For the nerves which enter and leave the brain and cord through apertures in their bony coverings she has, however, generally speaking, made no such wise provision, but has endeavored to compensate for her shortcoming by endowing them with a much greater power for repair than either the brain or cord.

The general construction and mechanism of the central nervous system with its peripheral appendages, the nerves, are analogous in all essential details to a **great telegraphic system.** By the nerves, which ramify in all directions like a lot of telegraph wires, the most distant parts of the body are brought into communication first with the spinal cord and then, if need be, with the central terminal station, the brain, where certain messages are received and interpreted by our consciousness, and others sent down through the appropriate nerves lying in the great cables (so to speak) of the brain and cord, to be switched off at the proper levels to their destinations.

When we consider that it is upon the perfect integrity of the fine adjustment of this delicate and intricate organization that the healthy functional activity of every other tissue in the body, even to that of the most insignificant secreting gland, depends, we are in a position to estimate the extent to which our physical as well as mental well-being is under its control. To increase the marvel we have only to learn that Nature has seen fit to make what have been termed the master tissues of the body, the brain and spinal cord, dependent for their own vitality upon a blood-supply which comes to them through arteries which, for the most part, are what are called end-arteries, or arteries which have no communication with one another; a plan which means almost inevitable death to these parts when the arteries break down or become occluded.

With this brief statement of the paramount importance of the rôle played by the brain and nervous system in the carrying on of vital functions, we are in a better position to enter upon a consideration of the measures which may be adapted for the maintenance of these organs in a healthy state.

Influences of Heredity, Education, and Environment.—At the present day we frequently hear the term "born degenerate" used to designate some unfortunate who happens to be the possessor of a high-arched palate, misshapen ears, or an asymmetric skull, and who, under stress of circumstances, betrays some mental or moral obliquity. The argument is that Nature while inflicting upon this individual outward stigmata of her freakishness, has been equally unkind in the matter of moral and intellectual endowments, and that he, in sinning against well-recognized laws, is simply the victim of his own vicious organism. To argue thus is fallacious in the extreme, for it throws a most unwarrantable burden upon Nature, and leaves absolutely nothing to the account of two factors which are of vast importance in determining the mental, moral, and social status of every individual—namely, education and environment. In proof of this, one has only to seek in the circle of his own acquaintances. This all leads, however, to the matter of heredity and its influence upon a person's nervous and mental welfare. Upon this point may be quoted the following admirable statement of the facts in the case by Dr. James J. Putnam:[1] "Fortunately for the educational outlook, the evidence has begun to accumulate that a morbid inheritance is not the inevitably crushing and baneful thing that it has been thought. We come into the world, each one a being of limited capacity, but in other respects free to become what circumstances make us, and responsible, to the extent of our capacity, for our lot. We bring no ticket-of-leave which stamps us as drunkards or maniacs on probation, but we do bear, in the histories of our ancestors, a certificate that hints by what efforts and by what avoidances we can make ourselves reasonable successes in our respective lines. There is no original sin, and not even, as it seems to me, original propensity, but only original capacity and original limitation, and even limitation is only another name for latent capacity."

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[1] The Shattuck lecture—"Not the Disease only, but also the Man." By James J. Putnam, M. D., of Boston.

Anyone at all familiar with nervous and mental diseases must at once be struck with the unquestionable soundness and fairness of Prof. Putnam's point of view. It brings the question of personal equation and responsibility into its proper focus and hints at the happy results which we may confidently expect from a due regard for the laws of hygiene in its broadest sense. Certainly it presents a most striking and stimulating contrast to the pessimistic fatalism of the views previously alluded to.

With regard to the brain and nervous system the hygienic problem is a far-reaching one, and if we would attack it at its very source, we must ask ourselves at the outset by what efforts and avoidances we may expect to ensure the unborn child against the dangers which threaten the stability of its mental and nervous organization. This is a question which leads us directly back to the period antedating conception. In many unfortunate cases at this time the personality of one or both parents is, on account of alcoholism or other vice, for the time being, in a condition of morbid alteration, the deleterious influence of which may be profound and enduring. But proper care of the mind and body at this time is only the beginning of parental responsibility. From the commencement of pregnancy to its close, and all through the period of lactation, every effort should be made to divert from the mother all possible causes of nervous wear and tear, chief and foremost of which are worry and anxiety.

The nervous and mental hygiene of childhood antedating the school-going epoch is comprised in such elementary factors as proper food and clothing, an abundance of sleep, and life in the open air.

The advent of the school-going age presents many serious problems, and as it is often at this time that the laws of mental and nervous hygiene suffer the first infringement by which profoundly deleterious results are brought about, the whole subject is deserving of treatment at some length.

It is contended by certain authorities that American children are sent to school at too early an age and compelled to do an amount of mental labor incompatible with the healthy growth of their physical organization. With regard to this it may be stated dogmatically at the outset that, so far as children under twelve years of age are concerned, the danger of brain overwork has been unjustly exalted, for, with very few exceptions, their natural inattention and playfulness are their safeguard. Of far greater, in fact, of paramount importance, as far as nervous and mental welfare is concerned, is the matter of sunlight and pure air in the school-room, and of seats and desks which will not distort the pliant spines and chest-walls of such children, thereby impeding the circulation to the important nervous centers upon which the strain of study naturally comes. It is toward matters such as these that parents and educators should be led to turn their serious attention, for with such crying necessities unattended to, the present warfare which is waging in educational circles over the teaching of matters of tenth-rate importance, notably the food-value of alcohol, is superlatively premature, to say the least. Impure air we know not to be a food but a poison, and a distorted spine in a growing child is more easily acquired than corrected.

In regard to the class of children that form the exception to the general rule, a word of precaution is demanded. Such children come under the head of what may be termed the dangerously precocious, and for them the modern overstimulating methods of school-instruction are fraught with dangers not easily overestimated. As a rule they are frail in body and of a decidedly tubercular taint, the activity of their physical powers seeming to be in the inverse ratio to that of their mental. What such children really need is a repression rather than a stimulation of their mental faculties. For them the ideal training is one of their muscles and of their vegetative functions, and this they can get only by the freest possible life out of doors.

After the age of twelve the question of brain overwork really begins to assume proportions worthy of serious consideration, for it is then that what we may term the fancy-work of education commences. By this is meant that children are launched upon the variegated curricula of the high-school and academy, and are subjected to a process of mental gymnastics sufficiently arduous to strain the powers of an adult, to say nothing of children who are approaching that very important physical crisis, puberty.

Puberty and its attendant dangers to mental and nervous health have caused the expression of many extreme views. There is no question that in both sexes (but especially in boys) the psychical effect of puberty often outweighs the physical; hence we begin to observe the real awakening of the "ego," of the condition of self-consciousness, the proper trend of which means so much for the health of the nervous system. It is a period certainly when nervous and mental aberrations are not uncommon, but are we right in attributing them all, as certain authorities are inclined to do, to brain over-work? Such a contention seems wholly unjustified except in rare instances. The root of the evil lies largely in the mawkish sentimentality and artificial modesty which possess a large percentage of parents throughout the land, and prevent them from explaining to their children the mental as well as physical significance of the changes which the latter are destined to undergo at this period. The result is, in the case of the girl, that the establishment of the menses often comes as a mental shock which may prove the last straw in the genesis of a nervous breakdown, for which her "studies" have already paved the way. In the boy the reaction is different and frequently far more disastrous, for he, finding himself in the possession of a newly-awakened instinct, is often led into habits which may mean little less than absolute mental and nervous ruin.

This subject is well worthy of the serious attention of every parent and teacher. Much ill-considered treatment of the problem has found its way into textbooks of medicine and medical writings in general. This, it seems, arises from an undue exaltation of the importance of the direct physical results. Such teaching is dangerous, for the naturally self-conscious youth is imbued by it with the fear of irreparable bodily injury, self-inflicted. A vicious cycle is established. He quickly becomes self-analytical, and by autosuggestion succeeds in bringing about actual physical suffering. The primary factor of moment is, however, the implantation of the morbid fear, and unless this is quickly eradicated, the complete nervous undoing of its victim is in time effected by misguided medical or lay advisors, or by the criminal insinuations of designing quacks, whose villainous publications are constantly flooding the country. The teaching of practical morality is the key to the problem. The responsibility of the entire matter rests primarily with parents and teachers; but to judge from the prosperity of the very lowest and most offensive sort of charlatans, and from the large number of persons who, under the scourge of the most pitiable mental anguish, seek the advice of reputable physicians, it would seem that this responsibility, great and significant as it is, rests, in many instances, with appalling lightness.

NEURASTHENIA (Nervous Prostration).

General Remarks.—In that limited number of cases in the class of children in which brain overwork can, with a reasonable degree of accuracy, be looked upon as the exciting cause of nervous breakdown, it may be said of them that they are usually the victims of inherent weaknesses coupled with a total disregard of the most elementary rules of personal hygiene; and the same statement is applicable to college men and women. The condition of nervous breakdown thus brought about differs in no important characteristics from that which arises from other causes, and as we commonly hear it spoken of as American "nervousness" or "neurasthenia," it will be well to consider all the factors which may be active in its production.

To speak of neurasthenia as a condition to which the American people are inherently liable is to neglect the facts of statistical evidence. The average American has no more *inherent* liability to suffer from undue exhaustion of his nervous powers than the representative of any other nation on earth. And yet, through disregard for the ordinary laws of hygiene, so many victims are added yearly to the number who fall under the evil consequences of an outraged nervous system, that the question of prevention becomes one of vital importance. To present this side of the subject in its proper light a preliminary study of the causes and results of nervous weakness, or asthenia, will be necessary.

Definition.—The term "neurasthenia" may be said to denote a condition of pathologic fatigue of the entire nervous system and also to connote a coexistent condition of morbid nervous irritability. Of its underlying pathology little is definitely known so far as the human subject is concerned, but from the experimental work of Hodge[1] and others on animals, to which reference will be made later, it would seem that we are not altogether justified in speaking of it as a condition without any discoverable pathologic basis.

Causation.—The subject of the causation of this condition is one of the deepest and most subtle with which the physician has to deal, embracing as it does a consideration of factors that concern not only the hereditary aspect of the individual, but also the educational, the latter term being used in its very broadest sense. These two factors, heredity and education, are the most important elements among what we may term the predisposing agents in the genesis of the morbid state under consideration. As a strong third comes occupation. The prolific inventor, the broker on the stock exchange, and others whose business affairs entail perennial emotional unrest, are found in the majority in the now great army of neurasthenics. School-teaching also seems to be fraught with danger.

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[1] Hodge, *Journal of Morphology*, Boston, 1892.

The question of social position as a predisposing element is often erroneously treated by writers both lay and medical. Neurasthenia is by no means an affection which is confined to the wealthy. On the contrary, it forms about 40 per cent. of the diagnoses entered upon the records of the nervous department of the Boston City Hospital, and the same fact probably holds true as regards the hospitals of other large cities.

As already said, the belief that Americans, as a race, are, by virtue of inherent peculiarities, especially liable to nervous breakdown is altogether erroneous. The error probably arises from the careless classification as Americans of all denizens of this country regardless of origin. The real fact of the matter is that the Semitic race furnishes by far the greatest quota of nervous sufferers.

As to the time of life at which the affection most commonly appears, it may be stated, as a general rule, that the period between the second and fifth decades stands preëminent, although cases are not infrequently met with at both earlier and later periods.

On the immediate or exciting causes of neurasthenia, there is no need of elaborate argumentation. They may be stated categorically in the following order: over-work, whether physical or mental, and prolonged morbid emotional excitement, such as worry, anxiety, vexation, and grief.

Symptoms.—If, as has been stated, it is upon the perfect integrity of the fine adjustment of the nervous mechanism that the healthy function of all the other organs of the body depends, and if neurasthenia is to be looked upon not only as a pathologic fatigue of the nervous system, but also as a morbid irritability, we should expect to find in a given case symptomatic evidence both of degraded organic function and of over-reaction to environment. And this is exactly what obtains. The check-rein of the nervous centers being loosed, the bodily functions run riot, and the sufferer presents symptoms of disturbance of digestion, circulation, secretion, and of the sexual functions. Nor are these all. The strict domain of the nervous system contributes its quota to the morbid complex, and we find the victim also offering symptoms of disturbed motion and sensation, both common and special, and of perverted intellection. He, or she, is weak and incapable of sustained muscular effort, as is easily shown by the diminishing power of successive hand-grasps, and by the tremulousness which accompanies even the slightest outputs of muscular force.

The sensory disturbances are of the most varied type. In many cases there are actual pains in various parts of the extremities and trunk; in others areas of heat or cold are complained of. Especially annoying are the headaches, which are sometimes referred to the top of the skull and sometimes to the base, and when in the latter situation, there is also experienced a feeling as if the head were too heavy for the shoulders, or as if it were being constantly pulled back by the neck muscles. Often the spine is tender throughout its entire length, at times exquisitely so. Tender spots are also found in various regions of the trunk, notably in the region of the breasts and over the stomach, and patients often complain of numbness and pain extending from the elbow along the inner border of the forearm into the ring and little fingers, the latter annoyance being most commonly experienced on awaking in the morning. Not infrequently dull, dragging aches in the extremities take the place of actual pain, and in addition to the aching there will be present curious sensations, "as though the blood were bubbling in the veins," or "as though the heart were beating all over the arms or legs."

The disturbances of the special senses are often very marked, one of the earliest being a blurring of the vision on using the eyes for any length of time. This may become so pronounced that the patient is totally unable to perform any labor, such as sewing, reading or writing, which requires steady fixation of vision for any length of time. The auditory annoyances usually take the form of adventitious sounds in the ears, such as ringing, buzzing, whistling, singing, roaring, etc., hearing itself never being seriously impaired. Disorders of smell are not common, but those of taste are frequently complained of; the sufferer saying that "nothing tastes right," or that there is a bitter or a salty taste in the mouth, without any reference to the taking of food. The disturbances in the intellectual sphere are very striking and often causative of the greatest mental anguish. (Finding himself incapable of fixing his attention for any length of time without great physical discomfort, the patient soon begins to fear that he is losing his mind, and this leads him into a habit of introspection which is often most pernicious in its consequences.) To the fear of insanity is shortly added a host of other fears, which so limit the capacity for initiation that the patient's friends often have to lend him their aid in the accomplishment of the most commonplace undertakings. He becomes emotional and cannot bear to read of accidents, murders, or sudden deaths from apoplexy or heart disease. His sleep is troubled, and he awakes more tired in the morning than when he went to bed the night before. Often on closing his eyes in bed he has sudden spasmodic jerkings of his legs, or a feeling as of falling. Real insomnia does at times occur, but most nervous sufferers very much underestimate the actual amount of sleep obtained.

The digestive disturbances are varied, but they most frequently consist in an inability to digest starchy food. Patients complain that everything they eat rests like a great lump of lead in the stomach, and the gas arising from the fermentative processes going on in the stomach often interferes to such a degree with the heart's action that it becomes accelerated and irregular—"feels as though it turned over at times." Sometimes there is a faintness or "all-goneness" within an hour or so after taking food. The movements of the bowels are capricious, but constipation is more common than diarrhea. As has been stated, the heart's action is frequently interfered with by the digestive troubles, but aside from this all sorts of anomalies of force and rhythm may occur independently and give rise to most intense anxiety. The pulse is often heard in the ear by the patient himself when the head is lying on the pillow, or felt whenever two parts of the body are brought in contact. The vasomotor apparatus of the blood-vessels is frequently so irritable that sudden flushings and pallors are common. The secretions are usually more or less generally interfered with, and the patient is often harassed by profuse and annoying sweatings, which may occur either by day or by night and may be general, or confined to the hands, or even to one surface of an extremity. Extreme dryness of the mouth is complained of in certain instances, in others salivation. Frequent micturition is common. Disturbances in the sexual sphere often find a prominent place in the morbid train. In women analogous symptoms occur in the same sphere, but with very much greater infrequency.

Fortunately, not every case presents all of the morbid conditions at the same time, or at any time; but a large number run nearly through the gamut if they are at all prolonged. This is especially true of those in which introspection plays a prominent part, and these are generally recruited from among the educated classes. With such people a little medical knowledge is a dangerous thing. They are morbidly alert for new symptoms, which, owing to the intense power of mind over matter, are not long in presenting themselves, and these they proceed to interpret in a fashion utterly false and illogic.

Pathology.—Of the pathologic substratum of neurasthenia little is thus far definitely known, but as we are morally certain that such intense fatigue of the nervous system as is logically assumed to be present in this condition cannot exist without leaving some structural imprint, it may prove interesting to note briefly the results obtained by the finer methods of investigation in animals, whose nervous tissues had, either by electric stimulation or by prolonged normal exercise of function, been brought into the condition of exhaustion. In these experiments the results obtained were always the same and had to do with the nerve-cells. These latter were found to be altered in size and shape, and in their constituent elements; the alteration being in the form of a general shrinkage, with irregularity of outline of the cell-nucleus and of the protoplasm. The chemic reaction was also altered. A further discovery of interest was that cells recovered after electric stimulation, but that recovery was slow, twenty-four hours' rest scarcely sufficing to bring it about after five hours' stimulation.

The above results of experimental investigation are most interesting and suggestive, and, while we are not warranted in saying absolutely that the same pathology holds good for nervous exhaustion in the human species, it requires no great stretch of the imagination to conceive of similar changes taking place in this latter condition. The symptomatic aspect of the problem is certainly more than sufficient warrant for such belief.

Prognosis.—The question of the duration of the affection is not the least important with regard to it. This, however, depends upon so many and so varied conditions that the outcome of the individual case must be decided on its merits. Recovery up to a certain degree is the rule, though at times it may be complete; but this takes place usually only after a long and discouraging siege which is marked by many relapses. Patients will often lose in a very short period whatever of gain they may have been many weeks in accomplishing. Hardly any of them come out of the conflict unscathed, and though many recover sufficiently to cope with the ordinary duties and trials of life, they are never quite capable of weathering its real storms.

Hygienic Treatment.—The subject of treatment proper does not come within the scope of this article, the point at issue being, rather, by what "efforts and avoidances," as Prof. Putnam puts it, by adherence to what hygienic laws, in other words, we may prevent ourselves, or those confided to our care, from drifting upon the shoals of nervous and mental degradation. In this connection, however, too narrow an interpretation must not be put upon the scope of these laws.

We are about to deal with matters mental as well as physical, and are therefore constrained, in considering the health of such a metaphysical structure as the mind, for instance, to embrace the moral as well as the physical aspects of the problem. And here it may be stated that the hygienic principles to be advocated by no means apply solely to the prevention of that single aberration of nervous and mental health which has been described under the term neurasthenia. On the contrary, they apply with equal pertinency to a very large number of equally preventable diseases of the brain and nervous system.

Every physician whose duties bring him much in contact with the victims of nervous and mental disease will unhesitatingly endorse the statement that the nervous and mental health of a nation is in direct relation to its moral health. The greatest scourges of the nervous system are syphilis and alcohol, and it is a distressing fact that many of the paralytics who go dragging their painful way along toward a premature grave, and that hundreds of other people who, in the very prime of life, meet with absolute annihilation of their intellectual faculties, are simply the victims of their own immoderate appetites and unrestrained licentiousness.

The Abuse of Alcohol.—The physiologic chemists tell us that alcohol received into the system is there consumed in the same way as starch and sugar, and that the energy yielded by it becomes kinetic in the form of heat—is transformed into muscular strength; further, that it takes the place of other food-ingredients in the actual nourishment of the body. These are the facts of physiologic research, of laboratory experimentation, and as such are beyond cavil.

Few physicians of experience will deny the great advantage to be derived from alcohol in combating the poison of fevers and in the maintenance of nutrition in certain debilitated states; but neither will they be inclined to deny that the kinetic energy stored up in the healthy tissues of a man by the introduction of one or two ounces of alcohol is likely to expend itself in ways detrimental to that individual's future nervous and mental—in fact, his whole physical and moral welfare.

Alcohol is certainly a poison for nervous tissues, and when taken constantly into the system, even though the daily amount be small, often produces organic changes. By persons of nervous temperament, so-called, the use of alcoholic stimulants is especially to be avoided, since the discomfort of the after-depression, even from the use of very small amounts, more than counterbalances the temporary sense of increased nervous energy produced.

The question of the advisability of the use of **tea, coffee, and tobacco** allows of a wider range of debate. A cup of coffee in the morning does no harm, and is often conducive to a satisfactory movement of the bowels. The excessive consumption of tea, to which many women of nervous habit are addicted, often to the exclusion of nutritious food, is, however, particularly to be deprecated. To the man of weak nerves the use of tobacco will never prove anything but harmful.

Of the virulency of the syphilitic poison on the nervous system and the subtle way it invades it—oftentimes years after the primary inoculation—volumes have been written. Let it suffice to repeat here that of the large number, especially of the young and middle-aged, who are yearly stricken with a sudden paralysis of one side, or one extremity, or who, for no other apparent reason than the commonly alleged "over-work," sink gradually into the gloom of complete dementia, the majority are its victims.

The lesson in moral hygiene thus relentlessly taught leads directly to the preaching of the necessity for the early and firm building of character as a nervous and mental safeguard. American parents are neither more indifferent nor careless as regards the mental and moral welfare of their children than people of other countries, although certain pessimistic writers on this subject would have us think the contrary. They do need, however, to have it firmly impressed on their minds that, in a country like ours, where independence is the watchword, this independence cannot with safety be made to apply to their relations with Nature; and, further, that if they would have their children preserve their mental and nervous equilibrium in the presence of the appalling vicissitudes of fortune so commonly observed in this country, they must early inculcate such saving principles as fortitude, self-denial, and self-control.

OVER-WORK.

As the direct, or exciting, cause of nervous and mental breakdown much emphasis has been laid upon over-work, both physical and mental, and this leads to a consideration of the measures which may be taken to avoid it. To formulate rules, however, which will fit every case is clearly impossible, since the whole subject resolves itself into the question of personal limitations. Everyone at all observant of his bodily and mental conditions must be fully cognizant of what Dr. Holmes[1] called the "curve of health." To use this author's own words: "It is a mistake to suppose that the normal state of health is represented by a straight horizontal line. Independently of the well-known causes which raise or depress the standard of vitality, there seems to be—I think I may venture to say there is—a rhythmic undulation in the flow of the vital force. The 'dynamo' which furnishes the working powers of consciousness and action has its annual, its monthly, its diurnal waves, even its momentary ripples, in the current it furnishes. There are greater and lesser curves in the movement of every day's life—a series of ascending and descending movements, a periodicity depending upon the very nature of the force at work in the living organism. Thus we have our good seasons and our bad seasons, our good days and our bad days, life climbing and descending in long or short undulations, which I have called the curve of health."

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[1] Oliver Wendell Holmes, *Over the Teacups.*

In this very shrewd observation are contained the elements of a practical and satisfactory working hypothesis. It teaches that everyone should strive to give due heed to the ebb and flow of his vital forces and regulate his periods of activity and rest accordingly.

Mental Over-work.—Many persons are either ignorant or unmindful of the fact that intellectual activity has a tangible physiologic substratum, but for proof that it has we need only to recall the picture which someone has drawn for us of a literary man hard at work, with an ice-cap on his head and his feet in a pail of hot water.

Physiologists have shown that intellectual activity is always accompanied by cerebral hyperemia; in other words, by a marked increase in the amount of blood contained in the vessels of the brain. This being so, we should refrain from bringing about this condition at a time when the blood thus attracted to the brain is urgently needed for the proper functional activity of the bodily processes, notably digestion. As an example of what often results from an infraction of this rule we have need only to look to the large number of cases of stomach and intestinal indigestion in brain-workers who persist in pursuing their intellectual avocations immediately after eating. It is obvious then that intellectual and digestive processes cannot, with any degree of comfort, be called into play at the same time.

The morning seems to be the time when the brain, after the repair occasioned by a night's rest, possesses the most "verve," and it is then that the bulk of intellectual performance should take place. Almost from the beginning of the day the process of running down goes on, and this running-down process seems to reach its maximum at about four o'clock in the afternoon. It is at this hour certainly that the vitality of the nervously weak often reaches its lowest ebb. There is, however, a subsequent increase in vigor, which is derived from taking the evening's meal, but the blood-supply to the brain has already begun to be influenced by the waste products of the active cells. These waste products ultimately accumulate faster than they are removed, render cerebral activity more and more difficult, and finally suppress it to such a degree that sleep intervenes.

This is the way, then, that Nature, if left to herself, would regulate the matter of waste and repair, and it would certainly be of great benefit to brain-workers if they took the hint from her and arranged their periods of mental activity and rest accordingly, even though they did so only to the extent of getting that portion of their brain-rest which is comprised in sleep, during the hours between ten o'clock at night and eight in the morning. With all due respect to opinions to the contrary, the brain-worker requires more sleep than the laboring-man, and he is certainly doing himself an injustice, against which his nervous system will sooner or later rebel, if he attempts to get along with less than eight hours.

Every now and then we are treated to an article in some popular magazine which informs us that some favorite author carries on his work at hours, and on the strength of an amount of sleep, which set all the laws of Nature at defiance. Whether this performance is exploited with the idea of stimulating the ambitious young man or woman to do likewise or not, is not known, but it certainly does not take much critical acumen to detect in the work of such an author positive evidence of a lack of sustained effort which is greater than can be accounted for on ordinary grounds. At all events the world would be far better off if it were spared much of the material which comes to us in the guise of literature, but is in reality the product of the same sort of cerebration that produces bad dreams and nightmare. Occasionally great thoughts will insist on forcing their way into the consciousness during the dead of night, but these occasions are, on the whole, so rare that we may with safety incur the brief loss of sleep which the recording of them on paper entails. Unfortunate examples of the effects of intellectual employment during the normal sleeping-hours are the cases of neurasthenia in editors and reporters employed on morning newspapers.

Worry.—The brain is an organ which, under proper training, is capable of performing an immense amount of work, provided only that the work is of a varied character and does not induce a corresponding amount of emotional disquietude. The importance of the emotions, especially the depressing emotions such as grief, anxiety, and worry, as factors in brain exhaustion, cannot easily be overestimated. It is a theme, however, which has been harped upon so much by writers on nervous diseases that the country at large seems at last to be awakening to the fact that some united effort should be made to obtain emancipation from at least one of the morbid list, and in consequence we now have the "Don't Worry" Society, among whose members are many hundreds of brain-workers. Such a popular movement is certainly commendable and will no doubt lead to much beneficial result. The old saying that it is not work but worry that kills is particularly relevant with respect to brain-work. A mere fit of low spirits, for the time being may cripple a man in the use of his intellectual faculties, but circumstances still tend to influence him, and he can review his position, even though he does so gloomily. His saving clause lies also in the fact that the turn of events and the moderating influence of time produce restoration of physiologic and psychologic equilibrium. Far different is it, however, with the man who is constantly worried, since neither time nor circumstance can do more for him than to press down the balance more heavily upon the side of both physiologic and psychologic unrest.

The Need of Mental Recreation.—With a terrible emotional incubus fastened upon a brain which is being forced to work in a single rut, as it is in the case of inventors, speculators, and promoters of schemes, it is easy to see why it soon comes to the end of its forces; and the hygienic hint therein contained is equally obvious. America is justly proud of her banker poet,[1] who has found abundant time to enrich the world of letters while still engaged in a pursuit which often taxes the mental and emotional stability of its followers to its utmost. Why should we not also produce littérateurs from the stock-exchange, or art connoisseurs from among the ranks of other callings, the slavish pursuit of which is fraught with such disastrous results to the nervous system? These are only a few ways that brain-rest may be obtained, but they are sufficient to indicate what brain-rest means. It is a very great mistake to suppose that cerebral activity can ever be brought to a stand-still. The brain is an organ which never ceases its activity, not even during sleep; of this we are often painfully made aware when we are suddenly awakened into the shivering consciousness of having experienced a bad dream. When we speak, therefore, of measures other than sleep that may be adopted to obtain rest for the brain, we merely mean those which aim at diverting its activity into channels that will afford a pleasant or soothing reaction upon consciousness.

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[1] Edmund Clarence Stedman.

The truth of this fact is strongly borne in upon us by the numberless failures of brain-workers to obtain needed rest through efforts which entirely neglect to give it its due weight. It is certainly a great mistake to try to escape the Nemesis of an over-worked and harassed brain by a feverish tour of the continent, or by a few weeks' unwilling sojourn within the deadly dull confines of a country village. The familiar and much-quoted lines:

> "Coelum non animam mutant,
> Qui trans mare currunt."
> (They change their skies but not themselves,
> That cross the seas.")

are extremely pertinent to the case in point, and should be memorized by all who are striving to work out the mental and nervous salvation of the brain-worker.

It is clearly impossible for the average stock-broker or scheme-promoter to become a shining light in the world of art or letters. That fact is fully appreciated in the proposition set forth. There is nothing lost, however, if such a person's efforts are not crowned with success, whereas the gain from the healthful mental gymnastics involved is often incalculable.

Thus far two general outlets for high-pressure cerebration have been mentioned; there are many others, and one of the most valuable is the **cultivation of fads.** Fads may be said to constitute a perfect mental antitoxin for the poison generated by cerebral over-activity. It is not necessary that they should be at all expensive or involve a great amount of time. The brain-worker whose purse will permit of no greater drain than that which is involved in the fad of stamp-collecting on a small scale, has just as great a chance for nervous salvation as the person whose bank account warrants the acquisition of a museum of art-treasures, and the writer feels confident that he has seen complete mental prostration averted in one instance by an overwrought young woman turning her attention to the study of the different weaves of oriental rugs. Among other fads which are helpful may be mentioned the collection of book-plates, rare books (which are often not expensive, though pleasantly elusive), old china and furniture, and old prints. The list might be prolonged indefinitely, but it will suffice to say that many not here enumerated will be suggested by a study of the circumstances surrounding the individual case.

To all this will undoubtedly be objected the plea of lack of time. The answer to arguments formed on such a flimsy basis is, that all time which is spent in preparing one's self as a candidate for a sanitarium, or, worse still, for a lunatic asylum, is like the proverbial edged tool in the hands of children and fools.

Physical Over-work.—Next in importance to brain over-work, as regards nervous and mental well-being, comes the question of physical over-work. The two subjects are, indeed, closely interrelated, and what has been said of the former from the standpoint of pathology and hygiene applies very forcibly to the latter. All motor activity, as has been shown, is the result of nervous energy; hence what we term bodily fatigue is in reality nervous fatigue. This does not imply, however, that the muscles do not undergo changes as the result of activity; they certainly do, but such changes are only of secondary importance as compared with those which are at the same time produced in the nervous system.

The changes pointed out by Hodge as occurring in the cells of the central nervous system of animals during extreme bodily fatigue have already been enumerated. There is still further evidence which goes to show that these central changes do not occur alone, but are accompanied by others that involve the intermediate portion of the neuro-muscular system, which we call the "terminal plate."

According to Abelous,[1] "spontaneous curarization"[2] takes place in fatigued muscles through the action of toxic substances produced by muscular action. This he shows by the following experiment: A current of electricity was passed through the body of a frog from mouth to anus in such a way as to produce complete tetanization in a given time. The current was then shut off and the frog left undisturbed for a time. On reopening the circuit it was found that the muscles, tired after the first excitation, were no longer capable of a new tetanization. It was discovered, however, that if the nerve of the left hind leg were excited, contraction was insignificant or *nil*, whereas excitation of the nerve of the right hind leg—whose artery had been tied—produced strong contractions in this limb.

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[1] Abelous, quoted by Brissaud, *Leçons sur les Maladies Nerveuses*, Paris, 1895, p. 323.

[2] By curarization is meant an action similar to that produced by a drug called curare (or woorari). This latter is an extract of uncertain composition, and is prepared and used by the natives of South America as an arrow-poison. The effect of immoderate doses of it upon the nervous system is to cause great muscular weakness and paralysis of all the voluntary muscles. The ends of the motor and sensory nerves are paralyzed; the former being affected first.

The conclusion drawn by Abelous from this experiment was that the toxic substances produced in the body by the tetanization of the muscles exerted their paralyzing influence through the circulation and upon the end-plates of the neuro-muscular system rather than directly upon either the nerves or the muscles proper. As nervous and muscular irritability was still preserved in the right hind leg, whose blood-supply was cut off by tying the artery, and not in the left, where the blood-flow remained unimpeded, Abelous's conclusion seems to be abundantly warranted. The results thus obtained from the study of fatigue experimentally produced lead us to consider whether or not they have physiologic analogues; whether, in a word, the state of the muscles of a man who is fatigued may be likened to that of the tetanized muscles of a frog. In the stiffness of the limbs which follows a prolonged walk there would seem to be a beginning tetanization. And as to the sensation which accompanies this condition, it would certainly seem that we are warranted in looking upon it as a sort of incipient auto-intoxication.

Both classes of experiments, that of Hodge as well as that of Abelous, are extremely suggestive, and point the way toward a clearer conception of the whole relation between nervous and muscular activity. They certainly lead us to be sceptical, to say the least, as to the absolute necessity of the building up of a vigorous muscular system—with all the output of energy which this process entails—as a safeguard to the maintenance of healthy mental and nervous balance.

On this point may be quoted once more that very keen observer, Dr. Holmes,[1] whose long and useful career is the best proof of the wisdom of his views. He says: "Do not think that a robust organization is any warrant of long life, nor that a frail and slight bodily constitution necessarily means scanty length of days. Many a strong-limbed young man and many a blooming young woman have I seen falling and dropping away in or before middle life, and many a delicate and slightly constituted person outliving the athletes and beauties of their generation. Whether the excessive development of the muscular system is compatible with the best condition of general health is, I think, more than doubtful. The muscles are great sponges that suck up and make use of large quantities of blood, and the other organs must be liable to suffer for want of their share."

Basing their judgment on the trite aphorism, "Mens sana in corpore sano," many enthusiasts would have us believe that if we are to entertain hopes of becoming intellectual giants we must set about acquiring the muscular force of a dray-horse; but if we take the trouble to consider how few of the shining lights of pugilism are also conspicuous in the arena of art or letters, for example, the fallacy of such a doctrine is at once apparent.

It is not even true that the day laborer, possessed, as he generally is, of a fine musculature, is equally gifted in the matter of nervous system. The deadly monotony of his avocation, with its freedom from emotional reaction, not infrequently proves too much for his mental and nervous stability. If any one desires proof of this, let him carry stones from one pile to another at a distance, say, of fifty feet, and when the first is exhausted begin to carry the combined stones of both piles back, one at a time, until both are heaped up on the site of the first. It will not require many repetitions of this process to convince the experimenter of its unquestioned ability to produce complete mental and nervous demoralization. Muscular exercise, like brain exercise, must, in order to be potent for the best good of the mind and nervous system, be such as to provoke pleasurable emotions.

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[1] Holmes, *loc. cit.*

We have already spoken of the power of worry to evoke mental exhaustion, and we shall not have far to seek for illustrations of its equal capability to annihilate muscular energy. Contrast, for example, the utter weariness produced in the young physician—if he be conscientious—by his first few cases, with the freshness with which his older, case-hardened confrère accomplishes his daily rounds; or the physical condition of the mother who has nursed her child through a long illness, with that of the paid nurse who is subjected to the same amount of fatigue-producing work without the emotional strain.

Regulated Exercise.—In thus emphasizing the meaning and danger of fatigue, there is no desire to discourage muscular exercise. The aim is rather, by force of contrast, to heighten its importance when carried out with due consideration to hygienic rules. The majority of people get all the exercise they need in the routine of daily life; it is for the sedentary and nervously constituted persons that we need to plan.

For the former a daily walk of three or four miles in the open air, at the rate of about three miles an hour, is sufficient; for the latter the problem is much more difficult and entails a study of the individual case. Some nervous invalids are incapable of exerting their muscles at all without provoking an expenditure of nervous force which leaves them bankrupt for weeks, and for them nothing more than massage and carefully regulated passive motion is desirable. Others suffer from what may be termed a "paralysis of volition," and are really capable of enduring a great deal more than they think. They should, therefore, be handled with the greatest circumspection. Their exercise should be taken in the open air, since the monotonous round of Indian clubs, chest-weights, and dumb-bells is to them invariably irksome and fatiguing. These persons need mental as well as physical gymnastics, and these, in the writer's opinion, are most abundantly offered by golf.

Golf is one of the greatest boons, in the way of outdoor exercise, yet offered to the nervously weak of both sexes. It is excellent from an esthetic standpoint, because the player's scene of action is a constantly shifting one and brings him face to face with Nature under new and varied aspects. Nor is this its only virtue. The mind finds both restful and absorbing occupation in the calculation of distances and in regulating the coördination of the muscles involved in the stroke. There need be no violent efforts, no hurry, no emulation; and the player mav always stop at the very first signs of fatigue. Curiouslv enough, however, the golfer is usually so completely preoccupied with the matter of "hazards" and "bunkers" that the amount of ground traversed is not appreciated, and delicate women often say that they are able to get over more ground, without fatigue, in pursuit of a wayward golf-ball than they had ever dreamed of in their most ambitious moments.

Bicycling.—For the somewhat more vigorous and self-reliant neurasthenic the bicycle is an excellent means of educating the nervous system, but the scope of its adaptability is limited largely to male sufferers. It certainly is not good for timid and apprehensive females, and attempts on the part of such to conquer a natural aversion for it should be encouraged only in a very limited number of cases, since the nervous outputs these attempts involve are far more often attended with disastrous than with happy results.

The use of the wheel implies work, often hard work; but it has a saving clause in the fact that it, even more than golf, affords opportunities for a constant change of scene. To the experienced rider the peculiar sensation, as of flying, which is often felt while wheeling along a pleasant road is very nerve-soothing, and gives him a sense of vigor that is indescribable. Often we have the opportunity to witness the delight of profoundly nervous but plucky patients on finding that they can ride the wheel several miles with comfort, whereas they cannot cover the distance of a few blocks on foot without great mental as well as physical suffering. And in some cases this achievement marks the turning-point in the road toward the recovery of nervous health.

Tennis is in most cases much too violent and exhausting for persons of weak nerves, but both **canoeing** and **boating** are very excellent for those who have a fair power of self-command. In addition to the output of muscular energy they both bring into play the balancing and coördinating faculties, and thus avert the danger of irksomeness.

Hunting.—To the neurasthenic of trained mind and innate, though perhaps undeveloped, love of Nature the sport of hunting often opens up new and varied fields of activity. It sometimes develops, for one thing, an unsuspected taste for taxidermy, and nearly always brings the special senses of sight, hearing, touch, and smell into a high degree of activity. The whole range of advantages is so enticingly set forth by a physician who found nervous and mental health in the sport, that we are impelled to quote parts of his story. He says:[1] "Travel was tried with some benefit, but I did not get the best results of my time till I took to the fields and forests—'gun in hand.' I never hunted and never owned a gun until I was past fifty. . . . I studied the habits of birds; used all the skill I could master in my efforts to get a shot, which often requires a great deal of strategy. . . . The eye is constantly under training, the ear also; every footprint of Nature, every motion and sound must be caught and analyzed. If a nut falls, if leaves rustle, or any unusual noise is heard, an immediate investigation must be had, and a quick decision made as to the cause. . . . Thus led by the eye and ear, the muscles of the entire body are called into the most delightful activity, with the least possible effort of the will, nearly resembling the spontaneous movements of childhood. The muscles seem to obey the active senses with real delight and with much less sense of fatigue than in any other mode of exercise. . . . The muscular system gains in strength, blood is sent to the extremities and to the surface, the skin becomes active, the brain is released of its excess of circulation, the nervous system is rested, the entire man refreshed and renewed."

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[1] Dr. Holbrook's *Hygiene of the Brain and Nerves*, p. 198.

There are still other modes of outdoor activity which are of undoubted value from a nervous and mental standpoint, but those already mentioned are sufficient to illustrate the underlying hygienic principles involved. To state the case briefly, the aim in all muscular exertion should be toward conservation rather than toward excessive outpoint of nervous energy in either its dynamic or its emotional form. It is thus, and only thus, that the organism can be brought into a condition which fits it to succumb to the regularly-recurring incidence of natural sleep.

SLEEP.

Of the reparative power of sleep and the necessity of securing it during the hours which Nature herself unerringly indicates, mention has already been made. It will be well, however, to consider the subject in greater detail, both in its physiologic and pathologic aspects.

Physiologic Considerations.—As already stated, the waste-products of activity appear to be the prime cause of sleep, and on them probably depends the distribution of the blood which has been observed during this condition. To make the blood-supply to the brain the primary factor of importance in the production of sleep—as certain physiologists have attempted—is, however, manifestly illogical, since drowsiness may be present synchronously with unquestionable cerebral congestion or the opposite extreme, cerebral anemia.

Under ordinary circumstances normal sleep may be said to take place without profound lowering of blood-pressure, and it is more than probable that it is due to the benumbing influence of the waste-products of metabolism mentioned above upon the cells of those areas of the brain-cortex which preside over the senses. A strong proof of the truth of this hypothesis is found in the following observation of Strümpell,[1] recorded many years ago: A young man had lost all power of sensation excepting through the right eye and the left ear. A bandage over the eye and a plug in the ear effectually barred all communication between his brain and the outer world. At the end of two or three minutes of ineffectual attempt on his part to arouse the sense of hearing by clapping his hands, his efforts ceased; respiration and pulsation were deepened and retarded, and the removal of the bandage showed the patient with his eyes shut in genuine sleep. Additional proof of the correctness of the above hypothesis lies in the fact that the majority of persons who possess the ability to fall rapidly asleep are individuals whose waking life is almost entirely sustained by their external perceptions. For them the production of slumber simply entails the securing of shelter from the sounds and impressions of the air and the shutting out of other excitants by closing the eyes. After these procedures very little remains for the production of ordinary consciousness, and sleep readily supervenes.

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[1] Strümpell, *Deutsch. Arch. f. klin. Med.*, 1864.

From the experimental standpoint also we have important evidence bearing upon the points under consideration. By the aid of the plethysmograph, Mosso[1] was enabled to compare the circulation in the human brain, laid bare by erosion of the cranial bones, with the movement of the blood in other organs of the body. The occurrence of sleep caused a diminution in the number of respirations and a fall of six or eight beats in the pulse. The volume of the brain and its temperature were at the same time slightly reduced through a diversion of a portion of the blood-current to other regions of the body. If during sleep a ray of light was allowed to fall upon the eyelids, or if any organ of sense was moderately excited without waking the patient, his respiration was at once accelerated, the heart began to beat more frequently, and the blood flowed more copiously into the brain. Similar incidents accompanied the act of dreaming. The renewal of complete consciousness was followed by an immediate increase in the activity of the cerebral circulation.

Attempts have been made to trace a resemblance between certain of the phenomena of syncope and sleep, owing to the fact that unconsciousness is a common attribute of both conditions; but it is clearly evident from the facts already adduced that the pathologically bloodless state of the brain which accompanies the former condition is in nowise analogous to the much less marked lowering of blood-pressure which accompanies sleep. The attempted analogy between the stupor of alcoholic intoxication and sleep is also highly illogic, and will receive further attention in the consideration of the measures for inducing sleep.

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[1] Mosso, *Ueber den Kreislauf des Blutes im menschlichen Gehirn*, Leipzig, 1881.

Insomnia.—From all the evidence at command we are justified in believing that if we can successfully disconnect, as it were, the cortical end-organs of the senses from stimuli coming to them either from within or without the organism, consciousness will be so far abolished as to produce sleep, and this gives us a rational basis upon which to work in the prevention of insomnia.

Insomnia is of two orders—functional and symptomatic, but only the former will be considered. This occurs most commonly in neurotic individuals and in overtaxed brain-workers, and may be complete or partial. As previously stated, many neurasthenics unintentionally exaggerate the extent to which they suffer from it. The pathologic basis of insomnia is probably to be sought, in the class of cases under discussion, in a persistence of the hyperemia, with its natural anatomic and chemic consequences, which accompanies intense cerebral activity. This supposition is rendered all the more tenable by the recent discovery of Obersteiner[1] of the presence on even the finer cerebral vessels of nerves which directly govern the blood-supply to the brain. These nerves, the discoverer further tells us, are easily rendered paretic and lose their power to respond at a time when those of other organs of the body respond readily. This being so, the acceptance of the pathologic view expressed is not difficult, and it will be seen that the severity of the insomnia will vary with the extent to which the cortical centers of the brain are exposed to morbid activity through a sort of paretic hyperemia.

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[1] Obersteiner, Prof. H. "Die Innervation der Gehirngefässe," *Jahrbuch f. Psychiatrie u. Neurologie*, Band xvi. Hefte 1 u. 2, p. 215 et seq., 1897.

Treatment of Insomnia.—For all but the most profound sufferers from insomnia the treatment is simple and easily carried out. Mental work should be performed during the first part of the day and restricted to four or six hours. The importance of outdoor exercise has already been emphasized. The bed-chamber should be cool; the bed hard and its coverings light. A fairly long time should be spent in preparation for retiring, but care should be taken that the feet do not become cold during this time, since the sensory stimuli thus provoked may in themselves be sufficient to keep the cortical centers alert and prevent sleep. Undue heat of any part of the body surface may also cause wakefulness; but for certain people a warm bath taken just before retiring brings about the desired result. Those who persist in going over in their minds the affairs of the day after their heads have touched the pillow should attempt to divert brain-activity by giving the stomach something to work upon, such as a glass of warm milk, a cup of hot bouillon, or even a glass of beer. Any large amount of alcohol should not, however, be taken at this time, since between the stupor thus often produced and the healthful restoration of energy which accompanies genuine sleep there can be no rational comparison. The bad effects of strong coffee taken at night need hardly be mentioned.

Prolonged insomnia, if it be absolute, is a very dangerous condition, and the measures necessary to overcome it are consequently more active. The patient—for the victim of continued insomnia must be regarded as a sick man or woman—should be kept in bed, and opium and its derivatives, as well as the whole group of so-called hypnotics, should be sedulously excluded. The mere application of mustard-leaves over the upper part of the chest and back for long-continued periods will frequently relieve uneasy feelings in the head and produce sleep for several hours. In using this remedy care should be taken not to blister the skin, since blistering is an unnecessarily severe measure. Counter-irritation, which is, of course, the object of the treatment just advocated, may also be secured by the application of bottles of warm water applied to the feet and back, and by the use of warm compresses over the abdomen. Very gentle shampooing or "massage" applied to the head and neck four or five times a day for a few minutes at a time is generally soothing. This should be done by the spread-out fingers, starting from the sides and back of the head, and being carried gently down to the clavicles and about the root of the neck. One of the best methods of depleting the blood-vessels of the brain is to draw the blood into the vessels of the abdomen by means of food. Food should, therefore, be given in small amounts at frequent intervals, and the largest meal should come at night. Gentle rubbing of the whole body, beginning with the lower extremities and working up, is a good method of eliminating waste-products from the tissues, but should not be done after six in the evening and never longer than five or six minutes at any time. If carried out after the hour indicated or for a longer time than five or six minutes, the rubbing is likely to excite the patient and thus defeat the purpose for which it is undertaken. In any case the danger of producing excitement is lessened by the use of oil on the operator's hands. Such advice may be contrary to the laws which govern the technic of massage; it is, however, not massage but gentle rubbing that is indicated in prolonged insomnia. If these measures are faithfully carried out, the resort to sedatives and hypnotic drugs rarely becomes necessary, and the danger of the formation of vicious drug-habits is happily averted.

Conclusion.—In closing, it is reiterated that affections of the brain and nervous system are in greater measure preventable than those of other parts; consequently the mental and nervous salvation of the individual is, practically speaking, to a very marked extent within his own hands, and may be worked out by him through rigid attention to the guidance of hygienic laws.

PHYSICAL EXERCISE.

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PHYSIOLOGY OF MUSCULAR MOVEMENT.

Spontaneous movement is the sign of life which appears the most typical and the most decisive to the popular mind. Nor is this instinct deceptive. For, although in the narrow, technical, and strictly scientific sense, life may exist without visible spontaneous movement, this is only possible for any considerable time in plants and in certain specialized animal cells: the blossom or the bacillus may live without moving, but not the bird; the liver-cell and perhaps the nerve-cell, but not the man.

The Muscles.—All the movements that are so characteristic of animal life—not only the voluntary movements, but the involuntary movements of the heart, the stomach, the intestines, the iris, and other organs—are carried out by muscles, which make up nearly one-half of the weight of the body of a man, and a somewhat smaller proportion of the body of a child. The voluntary muscles—such as the biceps, which forms the rounded, fleshy mass on the front of the upper arm, and the gastrocnemius in the calf of the leg—are connected, usually by cords or bands of dense fibrous tissue, called tendons, to the bones, and hence are also called the **skeletal muscles.** They consist of long, cylindric fibers varying somewhat in length and breadth, but on the average about $\frac{1}{500}$ inch in diameter, and an inch or even two or three inches long. The fibers are marked with alternate dark and light stripes, which run across their length, and from this appearance the skeletal muscles are termed **striped** or **striated muscles.** Each fiber is made up of a number of fine longitudinal fibrils arranged side by side, with a material of a different nature between them, the whole being inclosed in a thin sheath, called the sarcolemma. The fibers are united by connective tissue into small bundles, and these again into larger bundles, a number of which constitute what we call a muscle. In the connective tissue run the blood-vessels of the muscles. The capillaries, or smallest vessels, run close to the sarcolemma, but no vessel actually enters any fiber. The muscular fibers of the stomach, intestines, blood-vessels, etc., are much shorter and thinner than the striated fibers, and, having no transverse stripes, are spoken of as **unstriped** or **smooth muscular fibers.** The fibers of the heart occupy an intermediate position between the smooth and the striated muscular fibers. Like the latter they are transversely striped, but like the former they are not, in most individuals, under the control of the will.

Muscular Contraction.—The characteristic physiologic property of muscular fibers is that when stimulated they respond by a shortening or contraction without any change of volume. In this way the ends of the stimulated muscles come closer to each other, and if they are attached to bones these are made to execute movements, the direction, extent, and force of which depend on the direction of the pull of the muscle, the nature of the joint in which the movement takes place, the size of the muscle, and the degree of intensity of its excitation.

The contraction of muscle may be brought about artificially by stimulating the fibers directly, as by striking or pinching them, or by sending electric currents through them, or by suddenly heating or cooling them, or by putting into contact with them some chemic substance, such as common salt. All these forms of stimulation can be easily illustrated on the excised muscles of a frog. In the living body muscles are generally excited through the nervous system. In such a muscle as the biceps every muscular fiber is supplied with at least one branch of a nerve-fiber. The nerve-fibers are long branches, or processes, of nerve-cells situated in the gray matter of the spinal cord. These nerve-cells, again, are in close contact with other nerve-fibers running down from nerve-cells situated in the gray matter of the brain. When the biceps muscle is voluntarily contracted, "something" which we call a nerve-impulse, some change in the condition of the nerve, sweeps down from a definite region of the gray matter of the brain along certain nerve-fibers to certain nerve-cells in the upper portion of the cord, and, modified, perhaps, in these nerve-cells, is thence transmitted by the motor nerve-fibers to the muscle. What this "something" is we do not know, but it is probably a chemic change, which we may imagine running along the nerve with a speed somewhat greater than that of the fastest train in the world, and involving portion after portion of it, as an explosion runs along a train of gunpowder to one end of which a lighted match has been applied. When the nerve-impulse reaches the muscular fibers, it sets up in them changes of a different and much more energetic character, the external token of which is contraction.

We must, therefore, regard the muscle-fiber, the nerve-fiber, and the nerve-cell as a single machine or as successive links in a chain. If one link gives way, the chain is broken; if something goes wrong with one part of the machine, the whole is thrown out of gear. For instance, if the nerve is divided or crushed at any point between the muscle and the spinal nerve-cells from which its fibers come, or the spinal nerve-cells are destroyed by disease, the muscle is not only paralyzed immediately, but in a short time wastes away and becomes little more than a mass of connective tissue. In like manner, although the process takes a longer time, removal or permanent disuse of a muscle or group of muscles, as after amputation of a limb, particularly in young persons, leads first to enfeeblement and then to actual decay or degeneration of the nerve-cells in the spinal cord which are connected with it. In course of time even the corresponding group of nerve-cells in the brain may show unmistakable signs of wasting or atrophy. It is, on the other hand, exceedingly probable—and this is one of the most important points in the physiology of rational physical training—that increased use of a group of muscles, especially during the period of growth, leads to an increase in the size and efficiency of the nerve-cells of the spinal cord and brain which are connected with them, as it is known to do in the case of the muscles themselves.

Voluntary, Automatic, and Reflex Movements.—Most of our ordinary movements, and particularly those by means of which we act on our environment and adjust our relations to it, are brought about by a distinct act of the will. But certain nerve-cells connected even with striated muscles may discharge impulses that lead to **automatic contraction** of these muscles without voluntary effort and even in the absence of consciousness. Such are the nerve-cells which preside over the muscles used in ordinary respiration, the chief of which are the diaphragm separating the chest from the abdomen and certain muscles that elevate the ribs. Although we may, and often do, voluntarily alter the rate or the depth of our breathing, yet in general we do not think at all about it, and in sleep, of course, it goes on entirely without our knowledge. The impulses that set the respiratory muscles into action are discharged from a nerve-center or collection of nerve-cells in the medulla oblongata, a portion of the central nervous system which serves to join the spinal cord to the brain. Although the rate and intensity of its discharge are regulated by nerve-impulses carried to it by afferent, or sensory, nerves from the lungs and other organs, this respiratory center seems capable, even in the absence of such impulses, of sending out impulses along the efferent, or motor, nerves to the respiratory muscles. It is, therefore, spoken of as an automatic center, and the respiratory movements may be considered in part automatic movements. But the most typical examples of automatically contracting organs are the heart and the digestive canal, whose movements are entirely beyond the control of the will, except that in a few individuals an increase in the rate of the heart can be voluntarily produced and maintained for a short time.

A third group of movements embraces what are called **reflex movements.** Typical reflex movements are the winking of the eyelids when the eyeball is touched, and the drawing up of the foot when the sole is tickled. Everyone knows that both are quite involuntary. The nerve-impulses which cause the contraction of the muscles concerned are discharged by certain groups of nerve-cells constituting the reflex centers for these movements, situated in the case of the eyelid-reflex in the brain and in the case of the foot or plantar reflex in the lower portion of the spinal cord. The discharge is brought about by the arrival in the reflex centers of afferent impulses set up in the sensory nerves of the eyeball or the sole by the contact or the tickling. It is not necessary for the discharge of a typical reflex movement that the person should be conscious of the stimulus which gives rise to the reflex, or should experience any sensation from it. Many reflex movements can be elicited during sleep.

Work Done by Muscular Contraction.—A muscle is essentially a machine for doing work, but in the scientific sense the term work does not involve precisely the same idea as in the economic or the everyday sense; the former is wider than the latter. Thus, when a man lifts a weight against the force of gravity he does work in the scientific sense, whether the weight be a sack of coal, a book, the prostrate form of an opponent on the football-field, or his own body as he ascends a ladder or a hill. The amount of the work done by a contracting muscle is measured in terms of the weight which it raises and the height to which the weight is raised. For instance, if a muscle raises a weight of a pound to the height of a foot, it is said to have done one foot-pound of work; if it raises two pounds to the height of a foot or one pound to the height of two feet, the work done is two foot-pounds, and so on.

Transformation of Food-substances into Muscular Energy.—No work can be done without using up, or rather transforming, an equivalent amount of energy. Thus, a steam-engine transforms into work a portion of the energy stored up millions of years ago by the sun's rays in the primeval vegetation and set free in the burning of the coal. In like manner, a contracting muscle changes into work a portion of the energy stored up (again directly or indirectly by the sun's rays) in the food-substances, which are oxidized, that is to say, burned at a comparatively low temperature, in its fibers. The "burning" of food-substances in the muscle is essentially the same process as the burning of coal in the furnace of the engine, only in the muscle the oxidation takes place by some peculiar agency not at present thoroughly understood at a temperature of less than 100° Fahrenheit, while for the combustion of coal or of food-substances in a furnace a temperature of several hundreds of degrees is required. The products formed are, however, practically the same whether the food is slowly burned in the muscles and other tissues of the body or rapidly burned in the fire, the only essential difference being that in the body the combustion of the nitrogenous substances, such as white of egg or lean meat, is not quite so complete as it would be in a furnace, the nitrogen being given off in the form of urea, which can itself be further oxidized to nitrogen gas, carbonic acid, and water. Fat, starch, and sugar are fully burned in the body, the end-products being water and carbonic acid.

As regards the proportion of the total energy of the food which can be converted into work, the muscles are more economical than any machine yet constructed by man, since they can, under favorable conditions, do work equivalent to one-fourth or even one-third of the energy of the food-substances consumed in them, a proportion far in excess of the efficiency of the best steam-engines.

The most important of the food-substances used up in a contracting muscle is a sugar called **glucose,** or grape-sugar, which is formed in the body in digestion from starch and from ordinary cane-sugar, but also occurs in plants and can be produced artificially by heating cane-sugar with dilute acids. Another substance of importance is **glycogen**, sometimes called animal starch. It is formed in the body from glucose and other substances, and is always present in normal muscles, although it diminishes in amount, and may even disappear altogether, when the muscles are strongly stimulated for a long time, as when spasms are produced in an animal by poisoning it with strychnin. A certain amount of **fat** is also invariably present in muscles, and may be used up during their contraction.

The nitrogenous substances of the muscle do not appear, under ordinary circumstances, to furnish any large portion of the energy of the contraction, for muscular exercise, unless it is severe and prolonged, causes hardly any increase in the amount of such substances consumed, as indicated by the amount of urea excreted. On the other hand, exercise causes a marked increase in the quantity of carbonic acid eliminated by the lungs; and we have already recognized carbonic acid as the form in which the carbon of fats, sugars, and starchy substances leaves the body. When, however, the food consists mainly of lean meat, which contains little but nitrogenous food-substances, these are utilized by the muscles in contraction instead of the carbonaceous sugar and fat, which, so to say, they select when a choice is offered them. Under all circumstances a certain amount of nitrogenous or proteid food is required by the muscular tissue, for, as in all cells, the real, living framework of the muscle-fiber contains proteid substances as its essential constituents. We may, in fact, conceive of the fat and the sugar as bearing the same relation to the proper substance of the muscle as the water in the boiler and the coal in the furnace to the steam-engine—necessary for its work, yet perfectly distinct from it.

THE EFFECTS OF MUSCULAR EXERCISE.

Fatigue of Muscle.—It is a familiar fact that when the muscles are caused to work hard for a certain time they become fatigued. The process of fatigue can be best studied when a muscle—for example, one of the muscles on the front of the forearm which by their contraction flex or bend the fingers toward the palm—is made repeatedly to lift a weight attached by a leather collar to a joint of one of the fingers, the hand and arm being fastened so that none of the other muscles can assist. The number of contractions and the height to which the weight is raised by each are registered on a revolving drum, and the whole arrangement is called an ergograph. If the muscle is made to contract strongly and continuously, as when a heavy weight is held up by the finger, it rapidly becomes fatigued and soon the weight drops. But if each contraction is a short one, and is succeeded by an interval of rest, and if the weight is not too great, the muscle may go on raising the weight for a considerable time. Thus in an experiment of Lombard's one of the muscles of the hand lifted a light weight once every second for two hours and a half, or 9000 times in all, without showing any fatigue. An increase in the weight or an increase in the rate of contraction was quickly followed by fatigue of the muscle. Ultimately when the person has repeatedly raised a considerable weight with all the force which the muscle can exert, the time comes when a rapid decrease in the height of the contraction can be noticed, and sooner or later the effort to raise the weight fails. If the person still strives to raise the weight, a partial recovery of power takes place, after which the muscle again speedily becomes fatigued, and soon refuses once more to raise the weight. There is every reason to believe that when a muscle is fatigued by voluntary contraction the fatigue involves not only, nor at first chiefly, the muscular fibers themselves, but also the nerve-cells in the brain or cord. In fact, when the fatigue is pushed so far that it is no longer possible by a voluntary effort to cause the finger to lift the weight, it is the nerve-cells, and not the muscular fibers, which first give out. For at this moment direct stimulation of the muscle by an electric current will generally cause it to contract and raise the weight.

So far as the fatigue-process involves the muscle, it seems to be due to two things: the using up of the material necessary for contraction and the accumulation in the muscle of waste substances produced by the active muscle, for example an acid called sarcolactic acid, which resembles the acid formed in milk when it turns sour.

The restorative properties of food-substances in fatigue of muscle show conclusively that these materials are consumed in muscular contraction. The taking of a small amount of **sugar**, for instance, has been found markedly to lessen the fatigue and increase the endurance of soldiers tired out by long marches, and we have already seen that of all the food-substances in muscle, sugar appears to be the most important for the contraction. The fact that it is rapidly absorbed from the digestive tube also accounts in part for its restorative effect. Some enthusiasts have spoken of the almost magic change produced by the eating of a handful of granulated sugar. But it must not be supposed that the action is a specific one. Sugar may act most quickly in restoring fatigued muscles, but other food-substances have a similar effect; for instance, **fats** (especially when taken in the form of soups along with certain of the constituents of meat-extract), and the proteid substances contained in eggs and in lean meat. **Caffein**, the active principle of coffee, also causes for a time a marked increase in the capacity of a fatigued muscle to do work as measured by the ergograph. Small quantities of **alcohol** appear to have a similar effect; but in larger doses alcohol depresses the muscular power. And it seems now to be well established that in severe and continuous exertion, coupled with exposure to all weathers, as in war and in exploring-expeditions, tea, coffee, and cocoa are much more suitable stimulants than alcohol, although it ought not to be lost sight of that all of these things may be taken in excess. Trainers, also, as a rule, allow their men no spirits, and only very moderate quantities, if any, of wine or beer.

That in addition to the using up of the substances necessary to contraction, **the production of waste-substances** more quickly than they can be removed is responsible for the onset of fatigue, is indicated by the fact that the blood of a dog completely tired out by running, when injected into the veins of a perfectly rested dog, has been seen to produce in the latter all the symptoms of fatigue, which was not the case when the blood of a rested dog was injected. Further, the marked effect of massage of the muscles in removing the effects of fatigue would seem to show that the passage of the excess of waste-products from the muscular fibers into the blood and lymph is favored by the kneading of the muscles, which increases the flow of these liquids through the muscular blood-vessels and lymphatics.

Within certain limits the same effect on the **flow of blood** through the vessels of the muscles is physiologically produced **during contraction**, a very beautiful provision for giving the active muscle that increased supply of nutriment which it requires, and for carrying off at the same time the excess of waste-substances which it produces. This is brought about in two ways: by the widening of the small arteries, and therefore of the capillaries, of the muscle, through the action of certain nerve-fibers[1] which govern the caliber of the arteries, and at the beginning of the contraction by the pressure of the thickened muscle-fibers on the veins that carry the blood away from the muscles. These veins, like most others, are provided with valves in their interior which only permit the blood in them to flow out of the muscles and toward the heart, but not back to the muscles. When the veins are pressed on the flow in the former direction is increased. It has been actually observed that the quantity of blood flowing through one of the muscles used by the horse in feeding was three times as great when the animal was engaged in chewing oats as when the muscle was at rest. This is one of the local effects of exercise, and doubtless the increased supply of nutriment thus obtained is connected with the growth of muscles that are freely exercised, and which is so strikingly displayed in the "brawny arms" of the blacksmith and the general muscular development of the professional pugilist or acrobat.

There are also certain general effects of exercise which are of equal physiologic interest and hygienic importance.

The Effect of Exercise on the Heart.—It is well known that even a moderate amount of exercise causes the heart to beat more quickly. Thus in 74 healthy men it was found that running once or twice up and down two or three flights of stairs caused an average increase of 32 pulse-beats per minute, or not very far from 50 per cent. of the normal pulse-rate at rest, which is about 73 in the minute in the sitting posture and about 80 in the standing. The increase, however, was very different in different individuals, one man having a pulse-rate immediately after the exercise of 164 and another only 75. Unless the amount of exercise is excessive, although the heart beats fast, there is a steady, regular rhythm, so that the right ventricle sends more blood through the vessels of the lungs and the left ventricle more blood through the rest of the body than is the case when the person is at rest. The increase in the flow of blood through the lungs permits more oxygen to be taken into the blood and more carbonic acid to be excreted, and both of these circumstances are favorable to the actively contracting muscles, which use up far more oxygen and produce far more carbonic acid than muscles in repose. We, therefore, see that the quickly yet strongly beating heart is the ready helpmeet of the hard-worked and hungry muscles with their rapidly accumulating waste products and their dilated blood-vessels.

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[1] These are called vaso-motor fibers. They act on the blood-vessels by increasing or diminishing the degree of contraction of the smooth muscular fibers in their walls.

The Effect of Exercise on Respiration.—In order that the increased amount of oxygen may be easily obtained by the blood as it passes through the lungs, and the increased amount of carbonic acid contained in it easily discharged, more air must be taken into and breathed out of the lungs, and the respiratory movements are accordingly quickened during exercise as well as the heart. This acceleration of the breathing is brought about partly by the stimulation of the sensory, or afferent, nerves of the active muscles, which carry impulses up to the respiratory center, and partly by the direct effect of the carbonic acid, and perhaps other substances produced by the muscle, on the respiratory center as they are borne through it in the current of the circulating blood.

The Effect of Exercise on the Skin.—Another general effect of exercise is the reddening of the skin owing to the dilatation of its blood-vessels, and the increased excretion of sweat from its glands. The effect of the increased blood-flow through the cutaneous vessels is to heat the skin itself, but to cool the body, since more heat is given off from a warm surface than from a cold one. The evaporation of the water of the sweat has the same effect. In both of these ways, as well as by means of the increased ventilation of the lungs, the excess of heat produced by the active muscles is eliminated, and the temperature of the blood, even during the most intense physical exertion, seldom rises much more than a degree.

The effect of exercise on the digestive system, when it is regular and not immoderate in amount, is favorable. The appetite is increased; food is not only taken in larger quantity, but it is better relished, more fully and rapidly absorbed from the stomach and intestine, and more completely oxidized in the tissues.

PHYSICAL TRAINING.

Association with Mental Training.—The saying of Montaigne, which is sometimes quoted as a watchword by the advocates of physical culture, that "we have not to train up a soul nor yet a body, but a man, and we cannot divide him,'' expresses a truth which lies at the basis of rational education. It is, indeed, the strongest plea for systematic training of the body that it helps in the harmonious development of the whole man. Reference has already been made to the effects of exercise of the muscles on the nerve-cells connected with them in the spinal cord and brain. We have seen how near together in the bundle of life lie the muscular fiber, the nerve-fiber and the motor nerve-cell. So-called muscular fatigue we have recognized as in part fatigue of the nerve-cell. It is equally true that so-called muscular training is at the same time a training of the nervous centers, and that what in ordinary speech we term muscular agility is but the outward expression of a nervous agility, a readiness of reception of incoming impressions and a promptness of discharge of efferent impulses on the part of certain individual nerve-cells and groups of nerve-cells, extensively connected with each other and drilled to act in concert.

There is also good reason to believe that the effects of muscular training are not confined to the motor centers, but that they extend to other portions of the brain as well, even to those portions which are especially related to mental processes. It has, for instance, been clearly shown that many of our ideas, and some of them apparently the most abstract, are dependent for their completeness and vividness on the memory of muscular movements. To take an example cited by Sir James Crichton-Browne, when we think of a circle we involuntarily repeat in memory, although not usually with our muscles, the movements of the hand necessary to draw a circle or the circular sweep of the eyes necessary to view it. This, it is true, is not everything which is involved in our idea of a circle, but it appears to form an essential element in it. It is, indeed, not too much to say that the education of the nervous centers which have to do with the perception of ideas and with intellectual operations would be extremely incomplete in the absence of education of the centers connected with muscular movements. The distinguished writer on mental diseases, whom we have just quoted, goes so far as to speculate upon the possibility that "swaddling-bands so applied at birth as to restrain all muscular movements, and kept on during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance."

Apart from its effect upon the mental powers and its value as a moral gymnastic, as teaching discipline, obedience, and courage, physical education, according to M. Georges Demeny, a noted French authority, has three main objects: "to confirm health, to give a harmonious development to the body, and to teach how best to utilize the muscular force in the different applications which are demanded in life."

The kind of exercise which is most advantageous has not been definitely settled by the experts, and still less by the nations. The Americans and the English prefer outdoor games and athletic sports. The Germans, and especially the Swedes, are above all patrons of systematic gymnastic exercises directed to the development in due order and proportion, of all the muscles of the body. The truth appears to lie between the two extremes; and when we are free to choose the amount and nature of the exercise, as ought to be the case with those who direct the physical training of children and young people during the period of growth, both open-air sports and regular gymnastic exercises should have a place in our curriculum. For while outdoor sports and games are carried on, in general, under far healthier conditions and, as a rule, afford a greater amount of exhilaration and, therefore, of recreation than set exercises conducted in a gymnasium or in a stuffy bedroom, and being enthusiastically indulged in are not so liable to be shirked on slight pretexts, the development of muscles and education of movements produced by them is apt to be haphazard and lopsided. They should, therefore, be supplemented by some system of regular gymnastics.

During the period of development in childhood and youth systematic training of the body produces the greatest results. Dr. Hartwell, the Superintendent of Physical Education in the Boston Public Schools, who has had great experience in this matter, comes to the following conclusions:

During the first period of growth, from birth till the close of the eighth year—a period characterized especially by the great increase in size and architectural completeness of the brain—both games and gymnastics are valuable. But both should be simple, and should be directed rather to the development of such fundamental movements as those employed in walking and running, in bending the body, and in maintaining the erect posture, than to the acquisition of such skilled movements as the movements of the hands and fingers in playing the piano or the violin, or in handling many kinds of tools, or such rapid and highly coördinated movements as are necessary in many games.

The second period, from the beginning of the ninth to the end of the sixteenth year, is the time of most rapid growth in height and weight. In the increase in weight the muscles take the chief share, and the power of coördinating movements advances far beyond what was possible in the first period. This is the most important period for physical training, since neglect of it at this time can only be imperfectly remedied later on. Both athletic sports and gymnastics occupy an important place as agents of physical culture in this stage, and the "forms of exercise should be more varied, complicated, and difficult than in the previous period."

The third period lasts from the beginning of the seventeenth to the close of the twenty-fourth year. It is essentially a period of mental and moral development, and physical culture should be directed to increasing and perfecting the control of the nervous system over the muscular movements, and in particular over the vastly important group of skilled movements. During these years the handicraftsman, as a rule, acquires the delicate control of the muscles which he especially uses in his work, that manual cunning through which he is to earn his bread and which can hardly be fully attained to later on in life. To some extent the necessary labors of the workshop may, if carried on under proper hygienic conditions, replace special physical culture during the latter part of this period. When systematic exercises are employed, those which educate the muscles, or rather the neuromuscular apparatus, should preponderate, while in the whole of the first period and first half of the second hygienic forms of exercise should be the main thing.

Sports and Gymnastics.—Having determined that a combination of athletic sports with regular gymnastics is the proper method of physical training, the question arises—What are the best forms of athletic sports and the best system of gymnastics? No perfectly definite answer can be given. But if we keep in mind the triple purpose of physical training, to improve and confirm the health, to develop the body and the mind, and to confer upon the individual the particular form of muscular or manual dexterity which he may need in the serious business of his life, it is not difficult to make combinations of the two forms of exercise which will approximately accomplish the end in view.

Taken by themselves, those **athletic sports** which bring equally into play the upper and lower limbs (as wrestling, swimming, and rowing with two sculls or short oars and a sliding seat) are the best. But it is seldom necessary, and hardly ever desirable, to confine one's self to a single sport, and a game which involves chiefly movements of the legs may be supplemented by a game or a gymnastic exercise in which the arms are mainly used. It is in the possibility of graduating and varying the movements, so as to exercise every muscle in its turn, that scientific gymnastics shows its superiority over mere athletic pastimes; and of all the systems of gymnastics that first established by Ling, expanded and promulgated by Zander, and known now by the name of "**Swedish movements**" appears to be the best and most complete. It is impossible to do more than mention the subject here, and the reader who desires full information in regard to it is advised to consult a special work upon the subject.

The amount of exercise which should be taken cannot be stated in definite rules. Many persons, of course, remain in good health who take no systematic exercise at all. Sometimes the daily work provides as much as is required, and if the conditions under which manual labor is carried on are healthy, it would be striving for an unattainable ideal to demand, in addition, a weary round of gymnastic exercises. Doubtless the gentleman farmer whose bodily exertion is confined to riding about his fields or following the hunt, might be benefited by gymnastic training. But hardly the greatest enthusiast for physical education would expect a hard-working farmer or navvy at the end of his day's toil to find his chiefest relaxation on the horizontal bar or even in the mildest manipulation of Indian clubs. According to Parkes, the amount of exercise which an ordinary man should take is equivalent to about 150 foot-tons, that is, the amount of work necessary to raise 150 tons to the height of one foot. This is very much the same as walking about 9 miles on a good, level road, or cycling about 18 miles at a moderate pace, say 9 miles an hour. At this rate a cyclist can cover with a given expenditure of energy, measured by the amount of carbonic acid produced and eliminated by the lungs, two miles to the foot-traveler's one. But as the cyclist forces the pace the expenditure of energy increases very rapidly owing to the increase in the resistance opposed to his progress by the air. It should be remembered that a certain, and usually a not inconsiderable, amount of bodily exertion enters into the daily work of all healthy persons, and to this extent the amount of systemic exercise may be reduced.

Excessive Exercise.—Exercise, as such, ceases to be physically beneficial when pushed to the point of exhaustion. The severe strain of prolonged exertion may indeed give rise to dilatation of the heart, and even to lesions of its valves and to aneurysm. A certain degree of temporary dilatation of the heart has even been observed in soldiers after a long march in heavy marching order. A very rapid, unequal, and irregular heart-beat shows that the exercise is excessive and must be more gradually undertaken.

Certain diseases of the respiratory organs may also be caused by excessive exercise. Morally, however, the severest exercise may be of great benefit. For example, the grim determination which keeps the football-player in the field in spite of bruises and exhaustion may be very unphysiologic and even injurious as regards the muscles, but not necessarily so as regards the moral fiber of the man. For it is sometimes well in more important moments in the march of life that when the weary muscles cry "Halt!" the steadfast will should cry "Onward!" and compel the muscles to obey. But as a hygienic training, exercise should always be stopped before it becomes exhausting. This is especially true in the first and second periods of growth, and it ought to be carefully remembered that muscular relaxation is the natural complement of muscular contraction, and rest the complement of exercise.

Environment and Clothing.—Another point of practical importance is that when exercise is taken in a gymnasium there should be most thorough ventilation, since the elimination of carbonic acid by the lungs and the demand for oxygen by the muscles are so much increased. For the same reason no tight clothing which would hamper the free movement of the chest should be worn. For many kinds of indoor exercise it is well to strip the upper part of the body, and there is no danger of taking cold so long as the exercise is going on. Immediately it is over, or in the intervals of rest, the body should be covered. In winter the room should be properly warmed, but not too hot.

Muscular Exercise in Disease.—It is impossible here to do more than mention a few of the diseases in which local treatment of the muscles, either by massage (that is, stroking, striking, rubbing, or kneading) or by movements (passive, when carried out by the operator, active, when carried out by the patient), or by a combination of movements and massage, is employed as a remedial measure. For further information the reader is referred to special works on this subject. Such treatment has been found of value in certain forms of dyspepsia, habitual constipation, gout, derangements of the function of the liver without any organic disease, obesity, neuralgia (including sciatica), nervous prostration, some forms of paralysis, especially the acute paralysis of children, locomotor ataxia, St. Vitus' dance, writers' cramp, muscular rheumatism, some forms of dropsy, certain diseases of the heart and blood-vessels, lateral curvature of the spine, and sprains.

HOME GYMNASTICS.

By Albert McConaghy, M. D., of Seattle, Wash.

The series of home exercises herein set forth is intended to develop agility and suppleness and to encourage the normal activities of the muscular system. The aim is beneficent physiologic effect of exercise, rather than abnormal muscle-building; flexibility rather than hardness. The different movements are so arranged that those affecting the same parts of the body do not immediately follow one another. The avoidance of strain has been kept in mind; and at first all the movements should be practised lightly, always stopping short of actual fatigue. The effect of properly regulated exercise is to impart a sense of buoyancy and well-being, rather than one of exhaustion or depression.

During the interval between the exercises especial attention should be paid to the acquisition of the proper carriage of the head, shoulders, chest, and abdomen. In this way all the ordinary movements, such as walking, sitting, stooping, reaching, etc., become developmental exercises of far more practical value than any daily system of home gymnastics. It must also be remembered that no indoor exercise can ever supplant the common, healthful outdoor sports, such as walking, running, bicycling, swimming, golf, cricket, etc.

The importance of the abdominal muscles in all physical training should be emphasized. Lydston says: "Given the firm, well-developed abdominal muscle, it is hardly necessary to examine the rest of the muscular system. Any set of exercises which gives good abdominal development imparts an excellent general development. Abdominal protuberance in individuals out of condition is more apparent than real, and is due to flabbiness of the abdominal walls rather than to increase of fat or girth." By walking a stated distance each day with the abdominal muscles in firm contraction, a rapid and substantial development of their power and tonicity may be obtained. In fact, marked reduction of fat and diminution of abdominal girth, and, more particularly, abdominal protuberance, may be accomplished, simply by concentrating the attention on the abdominal muscles and keeping them in contraction while walking.

When possible, it is desirable to have a trained medical adviser to select the kind of exercises that are best adapted to the individual requirements, and to warn against the dangers that exercise may bring to persons with organic disease. Pregnant women should always avoid movements that cause strain of the abdomen and pelvis, and during menstruation the same precautions should obtain. The following **general rules** should be carefully read before the individual exercises are begun :

1. Before beginning these exercises it is well to evacuate the bladder, clear the nose of all mucus, and drink a glass of water, not too cold.

2. Except when stated otherwise, the fundamental position in all these exercises is : heels together ; toes turned out ; chest upward and forward ; arms hanging loosely ; abdomen drawn in ; and chin down and in.

3. The time best adapted for exercising is in the morning before breakfast. It is at this time that the

vitality is at its highest, and the movements can be done with greater regularity.

4. The room should be well ventilated but free from drafts, having the windows down from the top and up from the bottom. It is best to exercise in a room other than the sleeping apartment.

5. The clothing of the body should be loose-fitting, so as to leave the movements of the body unimpeded. The night-dress answers this purpose very well. The feet should be bare or stockinged, as this allows the ligaments and the muscles supporting the ankle-joints to be brought into play, and thus strengthened.

6. The exercises should be performed before a mirror. This lends interest to the work and the faults can be corrected better.

7. The mind should be concentrated on the work, and each exercise should be performed with precision. If home gymnastics are practised with absolute regularity, they soon grow into the daily habits of life, and the disinclination to exercise which follows erratic performance soon disappears.

8. In all exercises where the arms are in extension they should always be stretched out as far as possible.

9. As all these exercises will have a tendency to accelerate the breathing and the heart's action, it is better to rest a half minute after each movement.

10. The weight of dumb-bells for male adults should be from one to three pounds each ; those for ladies and children, not more than one-half pound each.

11. All the exercises in this series, with the exception of Nos. 2, 3, and 4, should be practised without dumb-bells.

1. **Stretching Exercise** (Fig. 70).—Lock the hands; stretch the arms out in front on a level with the shoulders. Without bending the knees, touch the floor, or as near it as possible. Straighten up the body, carrying the arms upward and backward above the head; then bring the arms down laterally (inclining them backward) to the level of the shoulder; then out in front to starting position. Throughout this exercise extend the arms as far out as they will go. The movements should be repeated ten times.

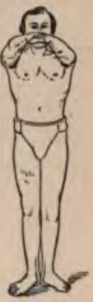
FIG. 70.

2. **Dumb-bell Exercise, A** (Fig. 71).—Bells on the shoulders. As the right bell is carried out from the shoulder, turn the head in the same direction. In bringing the right bell back to the shoulder, extend the left arm and bell, following with the head, and repeat. Do not allow the elbows to sink below the level of the shoulders, and do not roll the head—simply turn it, keeping the chin down. This is a good exercise to develop the arms, shoulders, and neck, and to correct an habitually bad carriage of the head. Repeat ten times, and gradually increase to fifty times.

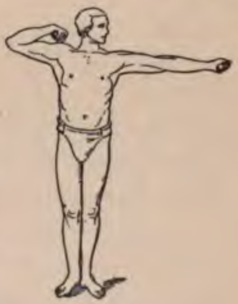
FIG. 71.

3. **Dumb-bell Exercise, B** (Fig. 72).—With the elbows fixed at the side, alternately touch the thigh and chest with the palms up. This exercise develops the upper and lower arms. Repeat ten times, and gradually increase to fifty times.

4. **Dumb-bell Exercise, C** (Figs. 73, 74).—From the position with the arms at the sides carry the arms back and up to above the head; then down to the shoulders, bending the wrists; then out to the sides on a level with the shoulders; then back and down to the side of body. This exercise is useful to correct round-shoulders and contracted chest. Repeat ten times, and gradually increase to thirty times. When the hands are elevated above the head, **leg-exercise** may be incorporated in this movement by rising on the toes. As the arms are lowered to the sides, the body should be raised on the heels, bringing into action the extensor muscles.

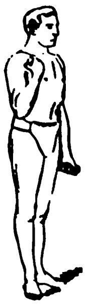
FIG. 72.

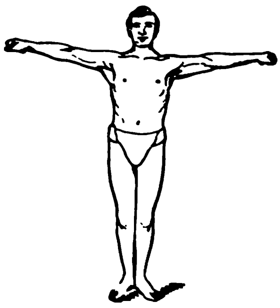
FIG. 73.

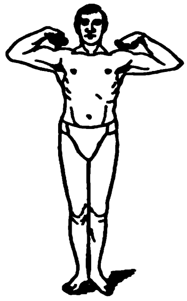
FIG. 74.

5. **Breathing Exercise** Fig. 75).—With the hands on the posterior aspect of the thighs slowly exhale all air from the lungs. As the arms are elevated to a position above the head, turn the palms up and the arms back at the same time, taking in a full, slow breath. As the arms are lowered, turn them backward and slowly exhale. The inspiratory act should be completed just as the hands come together above the

head, and the expiratory act should be completed as the hands reach the sides of the body. At the end of the expiratory act, bring the chest into a state of extreme contraction by crossing the arms in front and bending forward, at the same time making a forced expiration to get rid of the residual air. Keep the mouth closed, and exhale and inhale through the nose. In raising and lowering the arms be sure to turn them backward, as this throws the chest in a proper state of expansion. Quick, jerky breathing might impair the elasticity of the lung-structure in men past middle life. This movement, besides increasing the girth and contour of the chest, develops the muscles of respiration and increases the vital capacity, elasticity, and circulation of the lungs. Leg-exercise may be incorporated in the manner described in the preceding exercise. Repeat ten times.

Breathing exercises are very valuable, and should be continually practised. Occasionally taking a deep breath while walking or in front of a raised window is a very useful practice. Many indoor workers would be greatly benefitted if they would raise the windows of their offices occasionally and practise deep breathing.

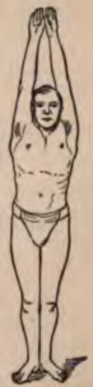

FIG. 75.

6. **Twisting Exercise** (Fig. 76).—Rest the hands on the hips with the thumbs turned back. Fix the eyes on a point on the walls opposite each shoulder, so as to avoid vertigo in turning. Then turn the body from side to side facing these points, at the same time rubbing the hands firmly across the abdomen.

In rubbing the abdomen do not localize the pressure to any one spot, but cover the whole abdomen. The head is never moved, but kept firmly in line with the body. This exercise stimulates the peristaltic action of the intestine, and is useful in cases of constipation and hepatic torpor; it is also indicated when there is an excess of fat on the abdomen. By bringing into play the rotary muscles and ligaments of the spine, this exercise is an excellent one for a weak back. Repeat ten times, and gradually increase to fifty times.

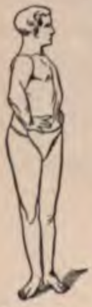

FIG. 76.

7. **Shrug Movement** (Fig. 77).—Elevate the shoulders as high as they will go without drawing in the head; lower the shoulders; rotate the shoulders forward and cross the arms at the wrists. Then throw the arms up, and when they reach the level of the chin, separate them and carry them backward, making a circle on either side of the body. This movement is an excellent one for round-shoulders and contracted chest. Repeat fifteen times.

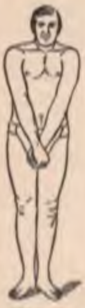

FIG. 77.

Leg-exercise may also be incorporated in this exercise, as well as in all the breathing exercises.

8. **The breathing exercise** (Fig. 75) should be repeated again for ten times.

9. **Forward and Backward Bend** (Fig. 78).—With the hands on the hips and the thumbs back, bend the body forward to a position at right angles with the legs; and as the muscles of the abdomen relax, firmly knead them, going over the abdomen from the lower ribs to the pubes and lat-

erally. As the body is bent backward, brace it by resting the hands on the hips. In bending backward allow the chin to rest on the chest. On the forward bend turn the face upward, and thus avoid cerebral congestion. By bringing into play the erector spinæ muscle, this movement is indicated for a weak back. It is also indicated in constipation, hepatic torpor, and excess of fat on the abdominal walls. Repeat ten times, and gradually increase to thirty times.

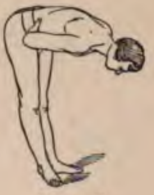

FIG. 78.

10. **Side Bend** (Fig. 79).—Bend the body to the side and touch knee, at the same time bringing the other hand into the opposite armpit; then reverse and repeat. In bending to the side, keep the body in the vertical plane. The tendency to bend forward or backward should be avoided. This movement strengthens the abdominal walls, and is, therefore, a preventive against hernia. It also strengthens the back. Repeat twenty times, and gradually increase to fifty.

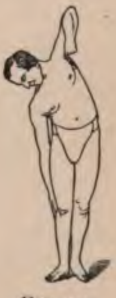

FIG. 79.

11. **The breathing exercise** (Fig. 75) should be repeated ten times.

12. **Wind-mill Movement** (Fig. 80).—The body should be bent at right angles to the legs, and kept in this position throughout the exercise. Bend the right knee, and touch the floor, or as near it as possible, with the right hand, at the same time carrying the left arm upward and forward above the head. Then, as the knee is straightened and the right hand is carried above the head, the left knee and hand assume

the position that the right one previously occupied. In changing from one side to the other do not elevate the body. This is a fine all-round exercise, and is especially valuable in cases of constipation, hepatic torpor, weak back, contracted chest, and round or drooping shoulders. Repeat ten times, and gradually increase to thirty times.

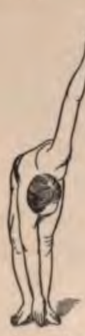

FIG. 80.

13. **Floor-exercise, A** (Fig. 81).—Lie at full length on the floor with the hands under the hips. Raise the legs without bending the knees to a position at right angles to the body, and return and repeat five times, and gradually increase to fifty. This exercise strengthens the abdominal muscles, and is, therefore, a preventive against hernia, and is useful in cases of constipation with fatty abdomen.

14. **Floor-exercise, B** (Figs. 82, 83).—Lie at full length on the floor with the hands under the hips. Bend the knees, and bring them up on the abdomen and return to starting position, and repeat. Do this movement ten times; then bring the knees alternately up on the abdomen fifteen or twenty times. The abdomen in persons unaccustomed to exercise is ordinarily very weak, and in such cases it is better to start with this exercise until the abdominal muscles have been strengthened. Then the other floor-exercise may be practised with greater ease. This exercise is useful in constipation and fat and flabby abdomen.

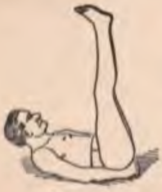

FIG. 81.

15. **The breathing exercise** (Fig. 75) should be practised ten times.

16. **Relaxing Exercise for the Knee** (Fig. 84).— Steady the body by holding on to a chair. Bring the leg to the position illustrated in Fig. 84. Relax the leg, and then alternately extend and flex it quickly. This is a good exercise to increase the flexibility of the knee-joint. Repeat ten times, and gradually increase to thirty times.

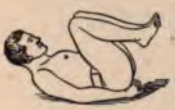

FIG. 82.

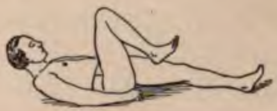

FIG. 83.

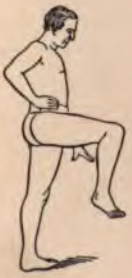

FIG. 84.

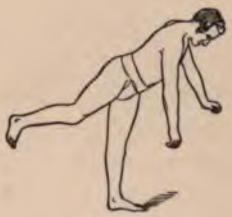

FIG. 85.

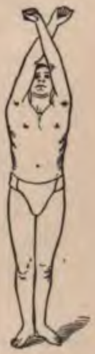

FIG. 86.

17. **Relaxing Exercise for the Hip** (Fig. 85).— Steady the body by holding on to a chair. Hold the leg straight but relaxed. Swing it backward and forward as far as possible. This exercise increases the flexibility of the hip-joint. Repeat ten times, and gradually increase to thirty times.

18. **Relaxing Exercises for the Shoulder (Fig. 86).**—Hold the arms out at the sides on a level with the shoulders. Swing them *downward* and cross them in front of the body, making two circles, ten times. Then, from the starting position, swing the arms *upward*, and cross them in front of the body, making two circles, ten times. Do both of these exercises quickly. This movement increases the flexibility of the shoulder.

DOMESTIC HYGIENE.

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THE subject of domestic hygiene includes all those factors in the home life of the individual which may be concerned in affecting his general health. Many of these factors, such as the ventilation, heating, water-supply, and sewage-disposal of the house, operate with equal force upon all the occupants, while other factors, such as the nature and quality of the food and the methods of preparation, operate more particularly upon individual occupants. Domestic hygiene, therefore, has reference to all those conditions and arrangements of the household which may exert a detrimental influence upon the health of the occupants. It also embraces a consideration of the arrangements and conditions which tend toward the improvement of the general health of the occupants, because the general health may be conserved not only by removing or avoiding those factors and conditions which directly or indirectly injure health, but also by introducing those factors and conditions which tend to improve the general health, and thus fortify the system against the contraction of disease.

CONSTRUCTION AND FURNISHING OF DWELLINGS.

Location.—The first consideration in the selection of a site for a habitation is the **nature of the soil** with regard to dampness and organic impurity, since these are the principal factors in rendering a soil unhealthful. The house should stand upon a site the subsoil of which is naturally dry or is properly drained and free from organic impurity. The configuration of the surface, the elevation, and the exposure are the most important factors in rendering the location favorable for a healthy habitation. The nature, source, and amount of the available water-supply should be investigated. The possibility for the economic and safe disposal of all refuse matter must also be considered.

The location should be of sufficient **elevation** to secure good drainage away from the house. A **southern exposure** is preferable, especially in colder climates. The proximity of large bodies of water and of marshy areas also influences the healthfulness of the location. The habitation should be so situated with relation to others surrounding it that an *abundant supply of fresh air and sunlight* can be secured. The healthful influences of sunlight and fresh air cannot be ignored. The absence of sunlight and the deficiency of fresh air are the most important predisposing factors of disease in the homes of the poorer classes in our large cities. When the house is located on open ground, a southern or a western exposure is preferable in order to secure the greatest amount of sunlight in that portion of the house most constantly occupied. The windows require protection with blinds and awnings in summer, to exclude the heat and glaring effect of the sun; but in winter the full and free action of sunlight, because of its purifying influence upon the air of the house, should be secured, at least during a part of each day.

Foundation and Walls.—Aside from the internal arrangement, the character of the walls, the materials of which they are composed, and the number of layers of these materials employed are important factors in determining the healthfulness of the house. So far as materials are concerned, there is no great hygienic difference in the selection of wood, stone, or brick, but the walls and foundation of the house should be so constructed as, so far as possible, to exclude dampness. This can be accomplished by means of double walls—that is, by providing an air-space between the inner and outer surfaces (Fig. 87).

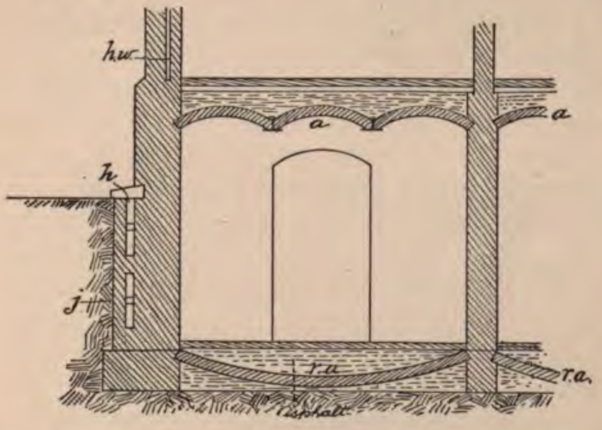

FIG. 87.—Double foundation walls; *h.w*, air-space between inner and outer walls of house; *h, j*, air-space in foundation-walls; *a*, arched roof of basement; *r.a, r.a*, reversed arch of basement floor.

In this manner the walls are rendered damp-proof and yet are not made impervious. The foundations and walls should be as dry as possible, and in damp soils this can be secured only by draining the subsoil below the foundations, and by cementing the foundation-walls and cellar-floor.

The roof of the house must be carefully constructed and frequently examined in order to prevent leaking. The material of which the roof is constructed is of no hygienic significance so long as it excludes rain. The rain-water falling upon the roof should be conducted away from the house through proper rain-leaders, so as to prevent the soil of the locality from becoming unduly damp from this cause.

The internal arrangement of the house is of equal importance with the site, materials, and mode of construction. The height and number of stories, the size and arrangement of the rooms, and the disposition of doors and windows, all have an important influence upon the health of the occupants of a house.

The minimum **height** of the stories may be stated as nine feet, while the maximum height may be placed at fourteen feet. The *amount of cubic space* which should be supplied for each person is about 1000 cubic feet. A room 9 × 12 × 9 feet would contain the amount of cubic space required for an adult. With the height of a room less than nine or more than fourteen feet, the problem of ventilation is rendered more difficult. In a room less than nine feet in height the other dimensions of space must be increased beyond those just given in order readily to supply the requisite amount of fresh air per individual, and, in consequence, the ventilation and heating become less efficient, because it is more difficult to secure regular movements of volumes of air on a horizontal plane than in a perpendicular direction. On the other hand, in rooms over fourteen feet in height, there is a tendency for the air to stagnate in the upper portion of the room and thus hinder the regular and complete displacement of the contained air by fresh air.

So far as possible, the rooms should be so arranged as to minimize the energy expended in going from one part of the house to another; consequently **stairways** should be avoided as much as possible. Unless the price of land demands it, the house should not be more than two stories in height. This will necessitate the extension of the building on a larger area of ground than is otherwise the case. So far as the architectural conditions are concerned, the effect can usually be made as pleasing, if not more so, in a two-story house as in one that is three or four stories in height. There is no doubt that the ventilation and heating of a house two stories in height are somewhat more difficult than in one having the same number of rooms, but which is three or four stories in height, owing to the difficulty of distributing currents of air in a horizontal direction. This difficulty does not, however, outweigh the evident advantages afforded in other directions.

The cellar should be well lighted and properly ventilated, and no refuse matter should be allowed to accumulate in it. If the cellar is allowed to become the dumping-place for refuse materials, the contained air will become tainted and find its way into the living rooms and vitiate the air of the entire house.

The kitchen should also be well lighted and ventilated, because the most important work of the household must be performed in this room. Scrupulous cleanliness should be exacted in the kitchen. The sinks should be carefully cleaned each day, so as to avoid the accumulation in them of grease and refuse matter, from which foul odors may be generated. The **refrigerator** should receive especial attention with regard to cleanliness. Unless the refrigerator is kept scrupulously clean, odors will develop that will taint the food contained in it and perhaps prove a cause of ill-health in the household.

All the **stairways** should have an easy slope. The **steps** should be broad and low, so as to minimize the energy expended in going from one story to another. The **hallways** should be well lighted, so as to avoid dark corners in which dust may be allowed to remain unnoticed and undisturbed. All unnecessary **draperies and curtains** should be avoided, because they permit dust to settle in them. The curtains should be composed only of such materials as permit of frequent laundering. Plush or velvet-covered furniture is also objectionable, because it does not admit of satisfactory cleaning. Where such furniture is in use, it would be preferable to provide linen covers which could be frequently removed and laundered.

The disposition of doors and windows should be such as to facilitate, so far as possible, the admission of fresh air and sunlight, the two principal health-giving agencies in nature. An effort should be made to have doors and windows on opposite sides of rooms, in order to facilitate cross-ventilation.

Walls and Wall-coverings.—The hygienic influence of wall-coverings is frequently neglected. It is usually the custom to cover the walls with wall-paper, and when this becomes soiled, another layer is placed over it. This process is often continued until the weight of the paper on the wall is so great as to become detached *en masse*. The practice of repapering without previous removal of the old, soiled paper cannot be condemned too strenuously. In this manner the filth accumulated through months and years of constant occupation is merely covered over, and may give rise to serious illness in the occupants, and is especially likely to retain the germs of disease in the house if efficient disinfection is not practised.

When repapering is necessary, the soiled paper should always be removed and the walls scrubbed with some efficient antiseptic solution, such as chlorid of lime, before a new coat of paper is applied. The use of wall-papers cannot be recommended from a hygienic standpoint. It would be far preferable to have the walls painted or kalsomined. Painted walls may be scrubbed and cleaned without suffering any detriment. Kalsomined walls can, when soiled, receive a fresh coating of kalsomine. The use of enameled brick for interior walls, with metal ceilings, gives a most pleasing effect and meets all hygienic requirements.

There is no doubt that, at least in part, the robust health of our ancestors is to be attributed to the fact that wall-papers were not then in general use. Usually the interior walls received frequent and liberal coatings of whitewash, and in this way were rendered aseptic at quite frequent intervals. It is well known that freshly slaked lime is one of the most efficient disinfectants.

Floors and Floor-coverings.—It is not generally recognized that the floors and floor-coverings in most houses are mere receptacles for filth carried on our shoes from the streets. The dirt is rubbed off on carpets and other floor-coverings, and settles there, to be distributed into the air of rooms through dusting and sweeping, thus becoming a direct menace to the health of the occupants. The floors beneath the carpets are often so constructed as to afford additional receptacles for the surplus dust which penetrates the floor-coverings. Under these conditions the slightest agitation of the floor-coverings by sweeping will serve to raise clouds of dust laden with the germs of disease, and there is no doubt that this is a fruitful mode of disseminating disease.

The floors should be impervious and free from cracks and crevices. Wooden floors can be placed in such a condition only by means of oil and paint. Here again the economy practised in the rural districts—that of *painting the floors* instead of covering them with carpets—tends to lessen the danger of disseminating disease. It is true that, to some extent, the same conditions are found in some of the better class of modern dwellings. Very pleasing effects can be obtained by means of *inlaid floors* of different colored woods.

With painted floors, the use of carpets and Japanese matting as a floor-covering is not required. Instead of carpets and matting, a few **rugs** may be used, and these meet all the hygienic requirements. They are not permanently fastened to the floors, as is the case with carpets, consequently they can be removed bodily at frequent intervals and the floor thoroughly cleaned. **Carpets,** on the other hand, are usually allowed to remain in place for months and even years, resulting in an astonishing accumulation of dust underneath, even with the greatest degree of cleanliness permissible under such conditions.

VENTILATION.

The necessity for maintaining the purity of the air of our homes is generally recognized. During the winter months it is impossible to keep the contained air of the same degree of purity as the outside air, since there is a certain amount of accumulation of the impurities arising from respiration, perspiration, and combustion. It should be our endeavor, however, to keep this accumulation as low as possible. This is accomplished by dilution—that is, by bringing in a constant supply of fresh outside air to displace an equal portion of the contained air. This is known as ventilation. The impurities arising from respiration, perspiration, and combustion which make it necessary to institute measures to bring about ventilation are, principally, carbon dioxid, water-vapor, and various forms of dust. While these substances are not in themselves directly poisonous in the amounts usually present in the air of ordinary dwellings, they are, nevertheless, injurious when constantly present in relatively large amounts for long periods of time, because of their depressing or irritating influence, and on account of the corresponding diminution in oxygen, the life-giving agent of the air.

The relative proportion of carbon dioxid in the air is taken as an indication of its purity. This is done, not because the carbon dioxid is in itself injurious in the amounts usually encountered, but because it is readily estimated and has been found by de Chaumont to be a fair indicator of the relative purity of the air. The estimation of the amount of carbon dioxid in air may be made in a variety of ways, but all the methods are dependent upon the same principle—the amount of precipitation produced in a definite quantity of lime-water (or similar solution) by a known volume of air. A simple household *method* for roughly estimating the proportion of carbon dioxid in air consists in washing measured quantities of the air with ½ ounce of lime-water in glass-stoppered bottles of different sizes (Fig. 88).

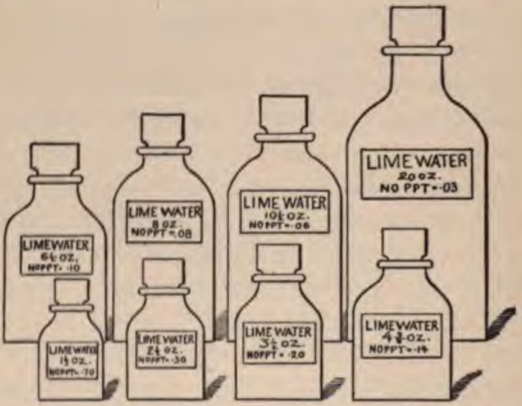

FIG. 88.—Household method of estimating carbon dioxid (Fox).

It must be remembered that outside air constantly contains carbon dioxid in amounts ranging from 0.03 to 0.05 per cent. So long as the contained air of our houses contains carbon dioxid as the result of respiratory impurity, not exceeding 0.05 to 0.07 per cent.,—that is, 0.02 per cent. in excess of the outside air,—we may regard the ventilation as satisfactory.

DeChaumont found that the relative purity of the air of a room can be determined in an approximate manner by the olfactory sense. The first impression obtained on entering such a room from the outside air is the best criterion of its purity. **The odor of organic matter** given off from the bodies of the occupants in a crowded room is very offensive, and the relative amount present is readily detected. Pure air will appear fresh and sweet, while organic impurities will render the air close, very close, or fetid, according to the amount present.

In overcrowded rooms there is always an excess of **humidity** in the air. The moisture in the air, when excessive, becomes a source of discomfort, because it diminishes the normal evaporation of moisture from the surface of the body, and consequently favors the retention of impurities in the body that should be regularly eliminated. In this manner excessive humidity of the air may also prove injurious to health. The amount of moisture in the air that is most healthful is about 75 per cent. of saturation.

The problem of ventilation is not an easy one to solve. It is a simple matter to bring in fresh air, but when the outside temperature is near the freezing-point, it is impossible to ventilate by merely opening the doors and windows. On this account ventilation is intimately connected with the problem of heating, since the cold outside air admitted displaces a corresponding amount of warm air. In the ventilation of buildings we aim to bring in fresh outside air in such a manner as to avoid drafts, since there is probably nothing more detrimental to health than a draft of cold air striking any portion of the body. We seek, therefore, to bring in the fresh air in a number of small continuous streams so as to prevent the sudden cooling of the contained air, as well as to avoid the production of drafts. The sensation of draft may also be overcome by bringing in the fresh air at such a height that it cannot impinge directly on the bodies of the occupants and at a temperature approximating that of the air of the room itself.

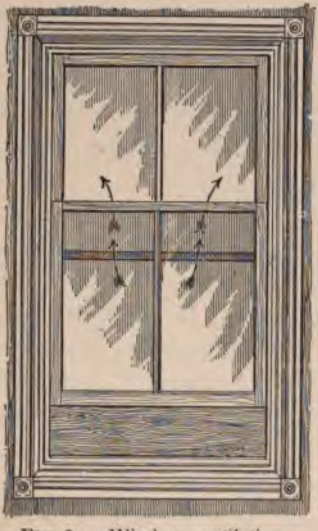

FIG. 89.—Window-ventilation.

Ventilation may be brought about either by natural means, as the result of movements induced by heated columns of air in ventilating flues, or by artificial means, as with fans or blowers. The former is known as natural ventilation, and the latter, as artificial ventilation. The frequency with which the air of a room is changed will depend upon its size and the number of the occupants. A space of 1000 cubic feet occupied by one individual will require a complete change of the air three times in each hour, in order to maintain its purity at the required standard.

Many devices have been suggested for bringing in fresh outside air in **natural ventilation.** The simplest of these is the insertion of a board under the lower sash of a window (Fig. 89). This simple arrangement allows the entrance of fresh air at the junction of the lower and the upper sash, and gives the incoming air an upward tendency. The cold air rises toward the ceiling and is distributed in all directions and then gradually sinks to the floor.

In **artificial respiration** the fresh air is either propelled through the house by means of a blower, or the contained air is abstracted by the same means, the fresh air in this instance gaining entrance through cracks in doors and windows and through porous walls and floors, or by means of special inlets. The results obtained by these methods—propulsion or abstraction—are equally satisfactory, although the propulsion method is preferable, because the incoming air may be warmed by passing it through or over steam coils, and the point of intake may also be selected with reference to the greatest purity of the air.

HEATING.

The object in heating our dwellings is to maintain the temperature at or near such a point as has been found most agreeable and most efficient in conserving the heat of the body. A temperature of 70° F. is agreeable to most persons. In the absence of artificial heat, in winter, our bodies lose their own heat quite rapidly and suffer in consequence.

Heat may be supplied in several different ways, as by means of stoves, open fire-places, hot-air furnaces, petroleum heaters, gas-radiators, and steam or hot-water radiators. When the heated object is placed in the room to be heated, we have heating by **direct radiation**, and when it is placed in some other part of the house, the heating is by **indirect radiation.** Stoves give rise to a great deal of annoyance, because of the dust produced and because of the unequal distribution of the heat. The same objections apply to open fire-places, and these also give rise to unpleasant drafts. Similar objections may be raised with regard to heating with petroleum and gas. In addition these fuels utilize large quantities of oxygen and thus rapidly impoverish the air of the rooms heated in this manner.

As has already been stated, ventilation is intimately connected with heating, since it is impossible to bring in fresh outside air without displacing a corresponding amount of the warm contained air. For this reason it is more economical and satisfactory to ventilate by means of previously warmed air, thus combining ventilation and heating. This **combined system of ventilation and heating** is exemplified in ordinary *furnace-heating*, in which the only source of heat is that supplied by the air which has passed through the furnace and become heated. There are several other systems of combined ventilation and heating in use, the most satisfactory of which is by *steam radiators placed in stacks*, through and over which the fresh outside air passes on its way to the different parts of the house. This combined system of ventilation and heating is now in very general use, not only for private dwellings, but also for office-buildings, hospitals, hotels, and schools. By regulating the size of the flues and the speed of the blower, a fairly definite amount of warm air may be supplied to each room according to its relative size and location. In ordinary dwellings it is usually unnecessary to employ a blower to propel the heated air, as the increased temperature imparted to it while passing over the steam-coils causes it to expand and thus gives it an upward tendency. The expansion of the air brought about in this manner is usually sufficient to produce the movement necessary for conducting it to all parts of the house.

In such a combined system of ventilation and heating it is necessary to remember that exits of corresponding size must be provided in each room for the escape of an equal volume of the contained air, since no more fresh heated air can be brought into a room than the amount of contained air that is leaving it at the same time. Oversight of this necessary provision is frequently the cause for dissatisfaction with this method of ventilation and heating.

In the heating of dwellings two things are to be guarded against; these are excessive temperature and undue dryness of the air. Aside from these two factors, the heating of dwellings has no particular hygienic significance, except in the production and distribution of dust and the gases resulting from combustion. Excessive temperature, undue dryness, as well as undue amounts of dust, are most frequently encountered in furnace-heated houses.

Excessive temperature may be avoided by proper control and regulation of the fire. Undue dryness of the air is less readily controlled. During the winter months the relative humidity of the outside air is generally not very low, but by the time it has passed through the furnace and become heated, its relative humidity is excessively low, simply on account of the increase in temperature.

The dryness of the air may be overcome, at least in part, by keeping the water-reservoirs of the furnace filled with water. This will give opportunity for the air to take up moisture on its way to the rooms to be heated. Besides this, several other measures have been introduced for increasing the humidity, such as placing a moistened sponge or a small jug filled with water before each inlet-opening.

The production and distribution of dust are readily controlled by the person attending to the **furnace-fire.** By opening the dust-flues before shaking or dumping the fire, most of the dust passes up the chimney instead of finding its way into the upper portion of the house through the hot-air shafts. The hot-air shafts should be taken apart and cleaned each fall before the furnace-fire is started, in order to remove the dust accumulated during the summer, otherwise this dust will find its way into the living-rooms in the first weeks during which the furnace is in use, and hence may prove of decided detriment to the health of the occupants. It is probable that this dust is, at least in part, answerable for the colds contracted at this season of the year, because of its irritating effect upon the mucous membrane of the respiratory tract.

Devices for Cooling the Air.—During the summer months it is desirable to cool the air. The method in common use is by means of small electric fans. These serve to propel the air through a room at a high rate of speed, and thus bring about a cooling effect by the greater evaporation from the surface of the body because of the rapid renewal of the surrounding air. This method of cooling the air is applicable on the small scale, as each fan acts only in the room in which it is placed.

The air of an entire house may be cooled by passing it through a chamber filled with ice. This, however, is a very expensive method. Passing the incoming air through a screen over which a spray of ice-water is falling will also serve to cool the air. Liquid air has been introduced recently as a means of cooling the air in summer, and has proved satisfactory in the ventilation of theaters. Within recent years Professor Gates, of Washington, devised an apparatus for cooling the air, which, it is claimed,

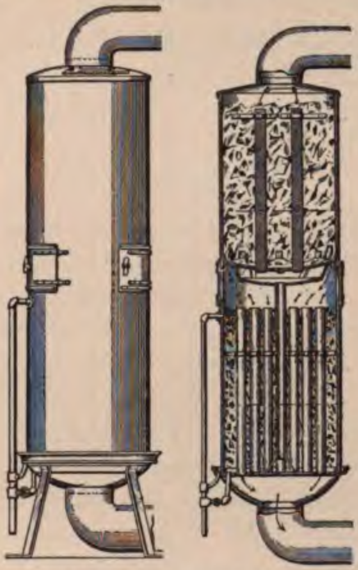

FIG. 90.—The "Nevo," an apparatus for cooling the air.

can be operated more cheaply than a stove. Professor Willis Moore, of the United States Weather Bureau, has also devised an apparatus—the "Nevo" (Fig. 90)—for this purpose. Neither of these appliances has as yet been so perfected as to pass beyond the experimental stage. Some apparatus of this kind is greatly needed.

LIGHTING.

The subject of lighting has already been discussed in detail in the chapter on the Eye (pp. 234 and 244), and requires no additional consideration here.

WATER-SUPPLY.

Consideration of the purity of the water-supply is of equal importance with that of the purity of the air-supply. According to the teaching of sanitarians of the present day, the principal water-borne diseases are typhoid fever, cholera, diarrhea, and dysentery. The specific causes of typhoid fever, cholera, and dysentery are now generally accepted to be well-known species of bacteria. The mode of entrance of these bacteria into the system is by way of the mouth, and takes place usually through the ingestion of infected water or infected food. The bacteria causing these diseases are thrown off from the body of the patient by way of the intestinal or urinary tract—that is, with the feces or urine. From these facts it will be seen that we usually contract typhoid fever, cholera, or dysentery by taking into our stomachs something which had previously passed through the intestinal tract of some other person. Hence it will be evident how important it is to have a water-supply that is free from these infective materials.

Municipal Water-supplies.—In thickly populated districts where the citizens have joined together to form municipal governments, the individual has the right to expect, and even demand, of the municipal authorities certain safeguards against agencies likely to jeopardize his health. In such communities the regulation of the purity of the water-supply is transferred from the individual to the municipal authorities. The individual has a right, therefore, to demand of the municipality a water-supply that is ample in quantity for all ordinary domestic uses and reasonably free from materials detrimental to health.

In localities where natural water, ample in quantity and of reasonable purity, cannot be obtained, it is incumbent upon the municipal authorities to purify the water that is least polluted and most readily obtained. The question of municipal water-supply has received a great deal of attention from sanitarians in recent years. Purification plants have been, or are now being, installed in a number of municipalities. The method of purification employed in any city varies with the inherent character of the water of the locality ; for instance, the water of the Ohio and Potomac Rivers has been found to be of such a character as to be more satisfactorily purified by the method of rapid filtration through sand, with the addition of alum as a coagulant to restrain the fine particles of clay found in these waters. The water of most rivers of the Southern States is of a similar nature. The water of the rivers of the Middle and New England States generally contains smaller amounts of clay, and for the purification of these waters the slow sand-filters, without the use of alum, have been found most satisfactory.

Domestic Filtration.—In those municipalities in which the water-supply is not free from danger to health, and where the local finances have thus far prevented the installation of satisfactory purification plants, the individual householder is obliged to apply such measures for rendering the water-supply safe as may be required by the local conditions. In many cities and towns where the water-supply has been notoriously bad for a number of years, individual householders have resorted to a variety of means for remedying the evil. Many of the hospitals, hotels, apartment-houses, schools, and private dwellings are equipped with individual filters which operate on the principle of the rapid sand-filters, using alum as a coagulant. These filters purify all the water entering the building, and if properly constructed and intelligently managed, prove quite efficient. Many householders purify the water used for cooking and drinking by means of filters composed of cylinders of unglazed porcelain, baked infusorial earth, or of sandstone (Fig. 91).

These filters act merely as strainers, since their fine pores prevent the passage of any bacteria. The serviceability of these filters is, however, of short duration. Usually in a few days the bacteria in the water grow through the pores of the filter and appear in the filtered water. Unless the filters are boiled or baked at frequent intervals, the filtered water will in time contain more bacteria than the applied water. It is necessary, therefore, to scrub and boil filters of this class once or twice a week in order to maintain their efficiency.

Other measures adopted for the purification of drinking-water in the household which are of value are **distillation** and **boiling.** Special forms of apparatus for distilling drinking-water have been devised (Fig. 92). These yield a pure and satisfactory water.

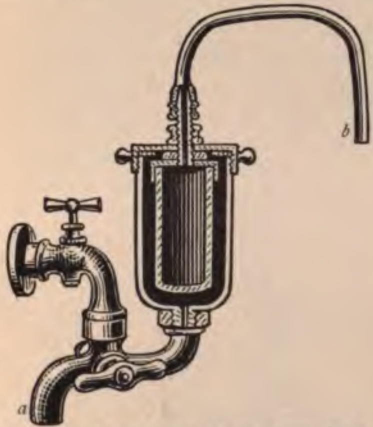

FIG. 91.—Household filter—Berkefeld: *a*, outlet for unfiltered water; *b*, outlet for filtered water.

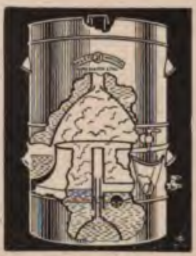

FIG. 92.—Domestic water-still.

PLUMBING AND DRAINAGE.

Sewers and Drains.—Where a general water-supply has been introduced, it is necessary to provide means for the removal of the waste-water. In most modern towns a system of underground drains or sewers has been installed in order to carry the household wastes away from the town limits. Where such a system of sewers has been provided, the household waste of each house is discharged through a four- to six-inch iron pipe into the sewer under an adjoining street. The large iron pipe which carries the sewage away from the house is known as the **house-drain** or **soil-pipe,** and into this drain is discharged all the waste from kitchen-sinks, laundry, bath-tubs, water-closets, and wash-basins.

All the connections with the house-drain, such as bath-tubs, sinks, water-closets, etc., are constructed in such a manner as to retain a small amount of water in a bend of the pipe so as to seal the connection and thus prevent the escape of gases from the house-drain into the rooms. Such a water-seal in the pipes is called a "**trap**" (Fig. 93).

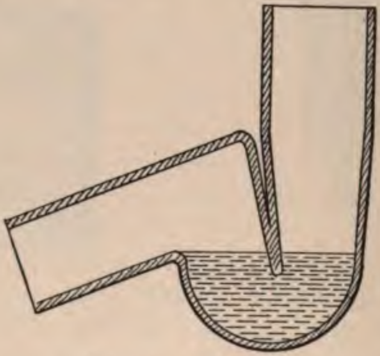

FIG. 93.—Anti-D trap.

In the plumbing of modern houses the house-drain is constructed of heavy wrought or cast-iron pipe of the same diameter throughout its whole length. It is provided with a trap between the house and the sewer, so as to prevent the escape of air from the sewer through the house-drain into the house. It is also supplied with a ventilator opening between the house and the trap for the entrance of fresh air. The house-drain is extended for several feet above the roof of the house, and its upper extremity is left open to favor a free circulation of air throughout its entire length. When constructed in this manner, and with all sink and water-closet connections properly trapped, there is no danger of the escape into the house of any air contained in the house-drain or the street-sewer.

All the connections of pipes entering the house-drain should do so at an acute angle (Fig. 94), and they must be tight, so as to prevent leakage of fluids or gases. This is a point that cannot be too rigidly observed. The principal danger from leaky joints is not so much the escape of gases, as the leakage of liquids and their accumulation on the premises. In fact, in modern dwellings, where the plumbing has

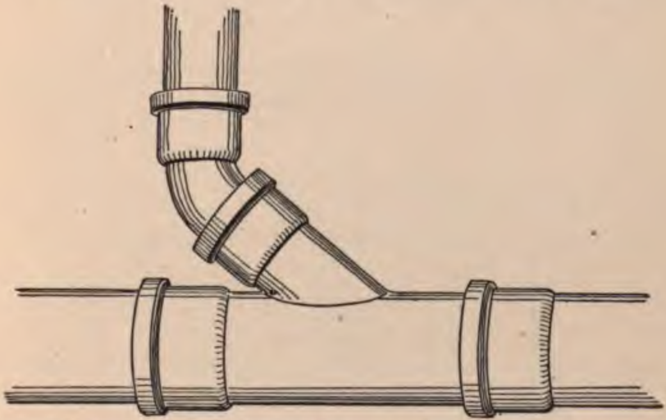

FIG. 94.—Method of connecting waste-pipe with house-drain.

been satisfactorily introduced, there is very little cause for apprehension from the so-called "**sewer-gas**," because in modern sewers and house-drains the air contained therein is not much more impure than the air of the overlying streets.

In the absence of a general sewerage system the house-drain should discharge its contents into a **cess-pool**. Where cesspools are in use, they should be located at such a point and constructed in such a manner as to avoid the contamination of neighboring wells or streams.

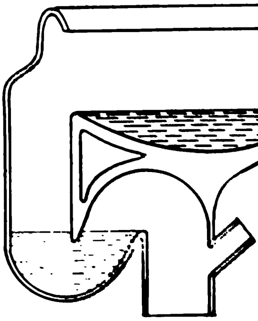

FIG. 95.—Wash-out closet.

Modern Bath-rooms and Toilet-rooms.—The general introduction of bath-rooms and toilet-rooms into houses has followed the provision of adequate water-supplies and the construction of sewerage-systems. These factors have had a beneficial influence upon the health of the inhabitants of modern towns. The introduction of bath-rooms and toilet-rooms has made it possible to secure a much greater degree of personal cleanliness and it has brought about a

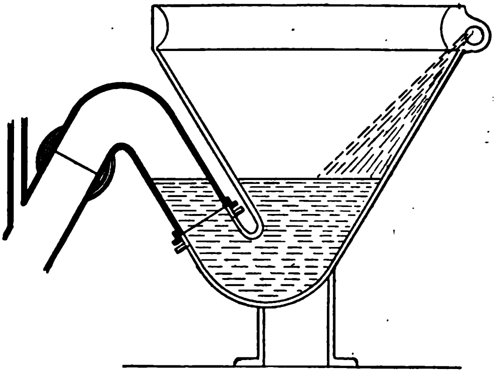

FIG. 96.—Wash-down closet.

marked reduction in diseases disseminated through sewage-polluted water.

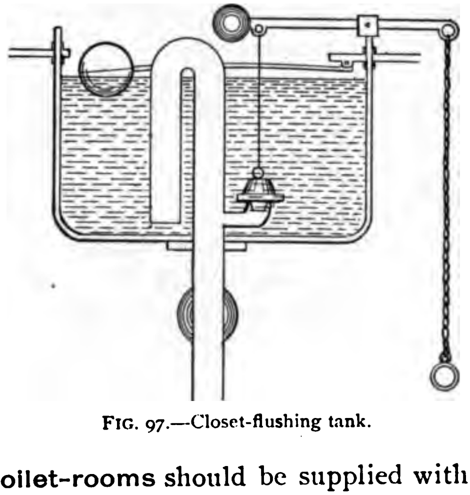

FIG. 97.—Closet-flushing tank.

The toilet-rooms should be supplied with **closets** of the *wash-out* or *wash-down* type (Figs. 95 and 96), and should be flushed by means of a separate water-supply furnished by a small tank of from two to three gallons capacity. Such tanks are known as "*water-waste preventers*" (Fig. 97), because the amount of water contained in them is sufficient efficiently to flush the closet each time it is used, and thus serves to prevent the use of excessive amounts of water for such purposes.

The bath-room should have the floor and side walls covered with tiling, so as to be impervious. The bath-tub should be porcelain-lined cast iron, as these are durable and readily maintained in a satisfactory hygienic condition. The inviting appearance of the bath-room fixtures will increase the frequency of their use.

DISPOSAL OF GARBAGE AND ASHES.

The health of the household can be preserved by the prompt removal of all materials which may serve as a source of nuisance in the form of disagreeable odors or of irritating dust. Consequently provision must be made for the systematic removal of garbage and ashes.

Garbage may be disposed of in several ways: It may be burned in the kitchen-range if the family is small. In larger households other means of disposal must be provided. Special furnaces have been devised for the consumption of garbage. In most cities and towns the municipality provides regular scavengers, whose duty it is to collect the garbage at regular intervals. Where this system is in vogue, the collections should be made at least once daily during the summer months, and two or three times a week during the remainder of the year. Complaints should be made to the proper officials if the collectors are derelict.

The disposal of ashes is a question which has received the attention of municipal authorities to a considerable extent and still awaits a satisfactory solution. The injurious effects of allowing ashes to accumulate on the premises are generally recognized, but their satisfactory removal has given rise to a great deal of discussion. For hygienic reasons the ashes should be removed at short intervals,—once or twice a week,—and in such a manner as to prevent the production of dust or the dissemination of litter. To overcome the latter factor, it would be preferable to provide separate collectors for waste-paper and refuse of like nature, so as to prevent their admixture with ashes. The dissemination of dust arising from the careless transference of ashes from boxes and barrels to the carts may be overcome by dampening the ashes a short time before the collector makes his rounds.

NUISANCES.

Under nuisances we may class such disturbances as foul odors, noxious fumes, loud noises, dust, smoke, and soot. Nuisances may not be directly detrimental to health, but they are indirectly injurious in that they engender discomfort and annoyance. Usually, these factors arise outside the home, and are, therefore, beyond individual control ; this is especially the case with noxious fumes arising from certain manufacturing industries, the loud noises of cities resulting from traffic over rough pavements, the shriek of factory and locomotive whistles, and the tolling of bells.

Foul odors may arise within the house through neglect of proper cleanliness of cellars, sinks, drains, and toilet-rooms. The odors arising from these places are best controlled by strict cleanliness. The use of various deodorants for their removal merely substitutes one odor for another, thus masking the odor without really removing it.

The noxious fumes arising from certain manufacturing establishments are sometimes difficult to control. Industries in which the generation of such fumes cannot be obviated should never be located in the residential portion of a town, but should be so located as to avoid becoming a nuisance, preferably in the outskirts of the town.

The noises of our modern cities are of such a nature in general that many of them, as the blowing of steam whistles and the tolling of bells, could be avoided. These could be reduced to a minimum, and in many instances they could be dispensed with entirely. The rumbling of trains, trolleys, and the heavy traffic on the streets, while not injurious, and frequently passed without notice by the well, are a source of great annoyance to the sick. Smooth pavements aid in reducing the noise from street traffic, and the more general introduction of self-propelling vehicles will also serve to diminish this source of annoyance. The transference of the surface street-railways to subways, although probably a long way off, will be an important measure in affording relief from this form of nuisance.

The dust of city streets is not only a nuisance, but a direct evil. It serves to distribute the pathogenic bacteria which are deposited on streets and pavements by promiscuous expectoration, as well as in the dissemination of the equally objectionable horse-manure. The advent of the *trolley car* has brought into operation a different and equally dangerous form of dust in the nature of *fine sand-particles*, resulting from the pulverization of the coarse sand used on wet and slippery rails. Aside from the injury to the eyes, these sand-particles produce irritation of the throat and lungs, and hence lead to a lowered vitality of the mucous membrane lining the respiratory tract, thus paving the way for subsequent infection. There is strong ground for the opinion that the marked increase in recent years of diseases of the respiratory tract, especially of pneumonia, is attributable to the influence of dust of this nature.

The removal of these nuisances will go far toward rendering our homes more healthful. The enforcement of laws against promiscuous expectoration in public places, the more efficient cleansing of our city streets (not the perfunctory cleansing in vogue at the present time, which is attended with the distribution of clouds of dust along the course of the street-cleaning gang, but the systematic flushing and cleansing of the streets in such a manner as to avoid raising dust and at such a time as not to interfere with traffic), and the introduction of underground railways, will serve to overcome in large part the discomfort and danger from the dust generated upon the streets.

The smoke- and soot-nuisance is one that can be overcome to a great extent if the proper measures are introduced. For those who live near lines of steam railroads or large manufacturing establishments, the smoke and soot generated are sources of great annoyance. This is especially the case where bituminous coal is used. Oil, when used as fuel, also gives rise to the production of smoke and soot. Devices for the consumption of the smoke by the fire under the boiler have been constructed. These serve to remove the greater portion of the smoke and soot, but are not in general use because they increase the first cost of the machinery and interfere somewhat with the efficiency of the engine. This problem still awaits a solution which shall be applicable under all conditions. The more general utilization of gas and electricity will serve to eradicate the evil in some instances.

HOUSE-CLEANING.

In order to understand what is meant by the term "house-cleaning," it will be necessary to define the word *clean* in its hygienic sense. The ordinary conception of the word clean is quite different from the chemist's conception of the word. To be chemically clean, an object must be free from everything that might interfere with or vitiate a chemic analysis. The sanitarian's conception of the word clean is, however, quite different from the chemist's, as well as from the ordinary conception of the meaning of the word. From a hygienic standpoint cleanliness means the absence of the specific causes of disease. Looking at the subject from this standpoint, house-cleaning signifies the removal of all factors which are concerned in the propagation or dissemination of disease.

While it is evident that in actual practice we rarely attain the ideal, it is essential, nevertheless, that the ideal should always be before us so that we may approach it as nearly as may be. In house-cleaning, therefore, it should be our *aim to remove all disease-producing agents* from the premises, as well as those factors which might tend toward the propagation or dissemination of disease. For these reasons **sweeping** should not be allowed. All dust should be removed by means of a dampened cloth or sponge.

The great **purifying agents** employed in house-cleaning which have been handed down to us by our forefathers are *washing-soda*, *soap*, and *hot water*, and these have not been improved upon as to simplicity, efficiency, and cheapness by any of the scientific discoveries of late years. Hot soap-suds and hot solutions of washing-soda are efficient germicides as well as satisfactory cleansing agents, and when freely used, serve to remove many of the disease-producing bacteria, as well as filth, and are all that are required to render a house "*clean*" in the hygienic sense of the word.

In cleaning a room occupied by persons suffering from contagious diseases these simple cleansing agents are usually reinforced by the use of more powerful germicidal substances. Such a room should first be disinfected by means of *formaldehyd*, applied either by means of a spraying apparatus or in the form of gas generated in a special apparatus (Fig. 98). After the room has been disinfected by one of these methods, it should be cleaned by the free use of soap and hot soda solution.

Washing and Laundering.—Under ordinary conditions the laundering of clothing has but little hygienic interest when the work is done at home. When cases of infectious diseases occur in the household, the clothing of the sick persons should never be laundered with those of the remainder of the family. The clothing of the sick should be placed into a receptacle containing water and some antiseptic, such as carbol soap, before it is removed from the sick-room. When moistened in this manner, it may be removed from the sick-room, and after standing in the antiseptic solution for several hours, may be washed in the ordinary manner.

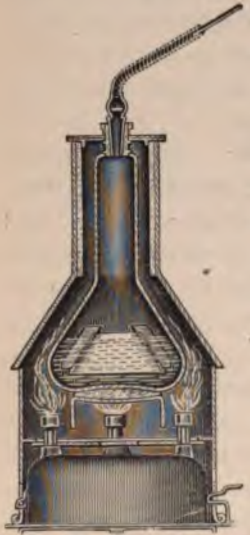
FIG. 98.—Formaldehyd gas regenerator.

Clothes-cleaning.—Articles of wearing apparel and bed-clothing that cannot be cleansed by washing require cleansing by other methods. When such articles have been exposed to infection, they should be disinfected by steam or by means of formaldehyd gas. Steam-disinfection requires a special apparatus, and consequently this cannot be carried out in the home. Disinfection by means of formaldehyd gas may be accomplished in the home. This may be done in several different ways, as by spraying the articles with a solution of formaldehyd, or they may be placed in a large closet which can be rendered air-tight and the formaldehyd gas generated in the closet with a Schering lamp, or the gas may be generated in an apparatus such as that represented in Fig. 98 and conducted into the closet through the keyhole. The last is the safer method, as the apparatus is under control and all danger from fire is avoided.

Woolen clothes, blankets, bed-spreads, and furs should be cleansed at stated intervals. Besides the disinfection just described, such cleansing operations should consist of measures directed toward the removal of grease and filth. Simple airing is insufficient for satisfactory cleansing. Exposure to fresh air and sunshine is of great service in purifying such articles, but fails to remove grease-spots. The latter should be removed by means of naphtha, benzin, or gasolin. Dirt and grease are freely soluble in those fluids, and they may be applied to delicate fabrics without detriment. These cleansing fluids may be applied with a sponge or cloth, or the articles may be immersed in the fluids. After having been cleansed in this manner the articles must be exposed to the air for some time to dry and allow the cleansing fluids to evaporate. After aëration for a day all odor of the cleansing fluids will have disappeared, and the articles are ready to be pressed with a hot sad-iron. When cleansed by this method and properly pressed afterward, the articles will appear almost like new and show no trace of the manipulation given them. It is necessary to be extremely cautious in the use of all these cleansing fluids, as they are highly inflammable. The cleansing operation should, therefore, always be performed in the open air, or at least in a room in which there is no light or fire.

FOOD AND DIETETICS.

The health of the household is dependent to a great extent upon the nature, quality, and quantity of the food-supply, as well as upon the manner in which the food is prepared. "Food is that which, when taken into the body, builds up its tissues and keeps them in repair, or which is consumed in the body to yield energy in the form of heat to keep it warm and create strength for its work."

All the various elements and chemic combinations of which the body is composed must be supplied in the food in order that it may perform its normal functions and obtain energy for the varied life-activities. A man of average weight and activity takes about 325 grams of dry solid matter and from 1500 to 2000 grams of water by the mouth, and about 550 grams of oxygen through the lungs each day. The solid matter taken as food should be composed of proteids or nitrogenous organic matter, of fats, and of carbohydrates. (See page 34.) A constant diet containing excessive amounts of any of the three elementary constituents, with or without deficiency of one or both of the other constituents, will in time prove injurious to health. In order to obtain the relative proportions of the elementary constituents required for nutrition we resort to a **mixed diet.** A deficiency in the elementary constituents of the food for a brief period is readily equalized by variation in the diet on different days of the week. Custom has served to bring about a selection of a dietary which generally meets the requirements of the body.

Nutritive Value and Cost of Food.—The following table (Table A.) shows the relative proportions

TABLE A.—*Nutritive Value and Cost of Food at Ordinary Prices.*

FOOD MATERIALS AS PURCHASED	Prices per ½ kg. (1 lb.)	Twenty-five cents will pay for—					
		Total food materials.	Nutrients.				Fuel value.
			Total.	Protein.	Fats.	Carbo-hydrat's	
		Grams.	Grams	Grams.	Grams.	Grams	Calories.
Beef, sirloin	25	500	155	75	80	. .	970
Beef, round	16	780	235	140	95	. .	1335
Beef, neck	8	1565	465	245	220	. .	2755
Mutton, leg	20	625	190	95	95	. .	1170
Ham, smoked	16	780	385	115	270	. .	2705
Salt pork	10	1250	1045	10	1035	. .	8775
Codfish, fresh	10	1250	135	. .	. .	. .	510
Codfish, dried salt	8	1565	255	250	5	. .	985
Mackerel, salt	10	1250	370	185	185	. .	2275
Oysters, 25 cents a quart	12.5	1000	120	65	15	40	520
Eggs, 25 cents a dozen	14.7	850	190	105	85	. .	1115
Milk, 8 cents a quart	4	3125	385	115	125	145	2030
Cheese, whole milk	15	835	545	235	295	15	3455
Cheese, skimmed milk	10	1250	675	480	85	110	2910
Butter, 25 cents a pound	25	500	430	5	425	. .	3615
Sugar, 5 cents a pound	5	2500	2445	. .	. .	2445	9100
Wheat flour	2.5	5000	4350	550	55	3745	16,450
Wheat bread	5	2500	1670	220	40	1410	6400
Oatmeal	5	2500	2260	370	180	1710	9225
Beans	5	2500	2110	580	50	1480	8075
Potatoes, 60 cents a bushel	1	12,500	2135	225	10	1900	8000

of the elementary food-constituents in some of the more common food-substances with the quantity that can be purchased for twenty-five cents, as well as the amount of energy that may be derived therefrom.

TABLE B.—*Analyses of Cereals and Leguminosæ.*

Composition of the Cereals.

CEREAL.	No. of analyses.	Nitrogenous substances.	Fat.	Nitrogen-free extractives.	Cellulose.	Ash.	Nitrogen.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Wheat	1358	13.89	2.20	79.75	2.19	1.97	2.22
Rye, winter	173	12.48	1.77	81.04	1.78	2.06	2.00
Barley	766	11.24	1.93	77.24	4.95	2.42	1.79
Oats	377	12.13	4.99	66.41	10.58	3.29	1.94
Corn, flint	80	11.74	4.78	79.20	1.67	1.40	1.88
Rice	10	7.00	2.00	84.76	4.00	1.16	1.12

Composition of the Leguminosæ.

	No. of analyses.	Nitrogenous substances.	Fat.	Nitrogen-free extractives.	Cellulose.	Ash.	Nitrogen.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Beans . . .	63	29.26	1.68	55.86	8.06	3.13	4.68
Peas . . .	72	26.39	1.39	61.21	5.68	2.68	4.30

Table B shows the composition of the more common cereals and leguminosæ used for food based upon a large number of analyses. This table shows that these food-materials contain the elementary food-constituents, expressed as nitrogenous substances, fat, and nitrogen-free extractives. The relative amount of these elementary constituents is such that excessive quantities of refuse matter and of carbohydrates must be taken to obtain the required amounts of proteids. This is the chief source of dissatisfaction with a true **vegetarian diet**—that is, a diet entirely of vegetable origin.

Cooking.—Aside from the composition of foods, the modes of preparation are of the greatest hygienic importance. Cooking has two principal effects on food-materials: it softens the food so as to render it easier of mastication and digestion, and it also renders it more palatable. In addition to these alterations cooking also serves to destroy all bacteria that may be lodged in or upon the food, and in this manner renders it free from danger to health.

The manner of cooking has a marked influence upon the digestibility of meats. The common modes of preparing meats are roasting, broiling, boiling, and frying. Roasted and broiled meats retain a large proportion of their juices, and are, therefore, more palatable as well as more nutritious. Boiling extracts the juices from the meat and consequently alters their nutritive qualities as well as their palatability. Frying in fats and oils causes the meat to be unusually rich in fat, and, in consequence, more difficult of digestion.

The purity of the food-materials is of equal importance with their quality and quantity. Foods may be adulterated in several different ways, as by the abstraction of some of the most valuable ingredients and the substitution of inferior or inert substances, and by the addition of various preservatives intended to prevent or retard decomposition.

Milk, for instance, may be adulterated by the abstraction of cream, the addition of water, or the addition of preservatives, such as formaldehyd or borax, and the addition of coloring-matters to mask the abstraction of cream. *Preserved fruits* are commonly adulterated by the addition of glucose, and *jellies* are frequently found on the market that are composed entirely of artificial materials, as glucose, coloring-matters, etc. *Baking-powders* are adulterated by the substitution of alum for more expensive ingredients. *Butter* is adulterated by the addition or substitution of other fats of vegetable and animal origin. *Olive oil* is adulterated by the substitution of the cheaper cotton-seed oil.

Food may cause infectious diseases from the presence in it of specific bacteria or parasites. *Milk* may contain tubercle bacilli when derived from tubercular cows, or it may contain pus-producing organisms (streptococci) when there is catarrh or inflammation of the udder. Milk may serve as the carrier of other disease-producing bacteria by the accidental entrance of such organisms as the bacillus of diphtheria, the bacillus of typhoid fever, the bacillus of dysentery, or the cholera organisms. These organisms usually gain access to milk by the addition of polluted water or by rinsing and washing the containers with such polluted water. Milk may also serve as the carrier of scarlet fever when this disease prevails in the family of the milkman or dairyman. Butter may serve as the carrier of disease in much the same way as milk.

Meat may contain the organisms of tuberculosis as well as the ova and larvæ of animal parasites, as trichina, cysticercus, etc. For these reasons meat should never be eaten in the raw state. *Green vegetables* may serve as the carriers of disease when they are raised in ground fertilized with night-soil. Lettuce may also convey typhoid fever or the ova of animal parasites when raised on such ground. *Oysters* are now recognized as frequent carriers of the bacillus of typhoid fever, on account of having been freshened in sewage-polluted streams.

Inspection of Foods.—The dangers from infected meat and milk and from adulterated foods in general can be overcome only by the most rigid sanitary inspection. These are conditions which the individual cannot control altogether.

The inspection of meats should include not only the routine slaughter-house inspection, but should also include rigid inspection of the meat exposed for sale in markets and shops. A great deal of the danger arising from the consumption of diseased and putrid meat can be avoided by such inspection. In this connection a committee of prominent physicians and veterinarians has recently made the following recommendations to the health authorities of Philadelphia:

> "First: All meat inspected by the meat-inspector should be stamped.
>
> "Second: The hours for slaughtering should be regulated, and butchers should be prohibited from killing animals at times other than those fixed.
>
> "Third: All slaughter-houses should be visited by the meat-inspectors during the hours of slaughtering, and all the carcasses should be examined, and those found to be in a condition suitable for food should be stamped.
>
> "Fourth: Beef prepared in the surrounding country and brought into the city in wagons should be brought in only at certain specified times, and before unloading the wagon should pass a certain inspection-point where the meat could be examined by an inspector stationed for this purpose, and stamped if found to be in sound condition.
>
> "Fifth: The meat-inspection force should be increased by the addition of a sufficient number of veterinarians.
>
> "Sixth: Sanitary regulations should be established governing certain features of the construction, fittings, and care of slaughter-houses, and all slaughter-houses falling below a reasonable standard should be proceeded against as a nuisance."

The committee also believes that there should be fewer slaughter-houses and more inspectors. In Paris there are 70 inspectors and only 2 abattoirs. In Berlin there are 150 inspectors and only 1 abattoir. In Philadelphia there are more than 100 slaughter-houses and but 5 inspectors.

The inspection of milk as practised in most municipalities fails to accomplish all that might be accomplished in this direction. The municipal inspectors rarely possess the authority to extend their supervision of the milk-supply beyond the limits of the municipality. Systematic inspection of dairies and milk-shops as to manner of production and storing of milk will accomplish a great deal. The licensing of all milk-dealers has served a useful purpose. The proper care of milk in the household is often neglected. Milk should be purchased in sterilized bottles and should be removed from these containers only when it is to be used. Milk should be placed on ice as soon as delivered, so as to prevent the too rapid development of bacteria in it.

The recent suggestions of a Medical Milk Commission appointed by the Director of Public Health of Philadelphia are as follows:

1. That all milk-sellers be required to obtain a license, and that such license be granted free of charge.

2. That no license be issued unless the dealer is willing to state the source of his supply, and to give satisfactory evidence that the producer from whom he receives his milk maintains his herd and premises up to the standard prescribed by the Department of Public Health; observance of such standard to be determined by periodic inspections under the direction of this same department.

3. That the standard to be established should correspond closely or exactly to the list of fifty dairy rules recommended by the Bureau of Animal Industry of the United States Department of Agriculture.

4. That dealers be required to remove all milk from the transportation trains immediately upon their arrival, unless in refrigerator cars, and to deliver the milk of the morning and previous evening on the day of its arrival, unless kept iced.

5. That dealers be required to have a special milk-room so situated in relation to their houses as not to be a thoroughfare. That its walls shall be tiled or painted with a glazed paint; that its floors be made of hard wood, cement, or other composition, or that they shall be covered with linoleum; that the room shall be well ventilated and kept thoroughly clean.

6. That it be required that all milk-wagons be thoroughly cleansed after each delivery, and that they be so constructed

that thorough cleansing is possible. That all utensils, such as dippers, etc., carried on milk-wagons, when not in use, be kept in separate clean cans.

7. That no dealer or producer be permitted to deliver milk in bottles who has not on his premises satisfactory appliances for the proper cleansing and sterilization of bottles and who does not properly use them.

8. That no dealer be permitted to fill bottles outside of his own milk-room. That dealers should be required thoroughly to cleanse and scald all milk-cans before returning them to the producer.

In conclusion, the Commission says:

"In addition to the tests which are at present applied by the Inspectors of Milk we would suggest that, in order to obtain some idea of the bacterial contents of the milk, the degree of acidity of the milk be determined and that all milk showing an acidity of more than 0.2 per cent. be condemned. That an examination by sedimentation be made to determine the amount of dirt per cent., and if found in more than a minimum quantity, that such milk be condemned.

"Any dairyman or dealer who is incapable of meeting such requirements should not be permitted to produce or sell milk. While we realize that a more rigid standard would be desirable from the standpoint of the public health, we recognize the impracticability of attempting to establish such standard at the present time. We deem it advisable to approach the higher standard by gradual stages, insisting upon a strict enforcement of the moderate suggestions recommended."

CAUSES AND TRANSMISSION OF DISEASE.

The physical causes of disease are such physical agents as heat or cold, excessive or deficient humidity of the air, contusions, wounds, accidents, dust, and winds. Changes in barometric pressure, as in balloon-ascensions or in mountain-climbing, where the air is rarefied, and in work in deep mines, in caissons, or submarine operations, where the atmospheric pressure is increased, may prove injurious.

The vital causes of disease are the different species of bacteria and vegetable and animal parasites. The bacteria cause disease by the production of virulent poisons which are destructive to the blood-cells and tissue-cells. The animal and vegetable parasites cause disease through the destruction of the blood-cells and tissue-cells, by the absorption of nutritive materials, and by the obstruction of important tissues and organs.

The chemic causes of disease are the numerous chemic substances which are destructive to the tissues with which they come in contact.

Transmission of the infectious diseases may be effected in a variety of ways: By drinking-water, food, air, soil, wounds, direct and indirect contact, and through the agency of insects. The diseases which are transmitted by *drinking-water and food* are those which have their primary seat in the digestive tract. The diseases which are transmitted through the *air* are those affecting the respiratory tract. The eruptive fevers may also be transmitted through the air. The diseases which are most likely to be transmitted through the *soil* are tetanus and malignant edema, and the organisms causing these diseases are usually introduced into the body through punctured or incised wounds or through abrasion. Many diseases are probably largely transmitted by *contact*, direct or indirect. Indirect contact may take place through the agency of anything that has been used or handled by the person suffering from the disease, as clothing, cups, napkins, handkerchiefs, money, books, etc.

Insects and vermin may serve to transmit disease either directly or indirectly. Examples of the direct transmission of the organisms of disease by means of insects are the transmission of malaria, yellow fever, and filariasis through the agency of certain species of *mosquitos*, and the transmission of relapsing fever through the agency of *bedbugs*. The indirect transmission of disease by insects occurs when the insects, such as flies, *cockroaches*, and bedbugs, become contaminated with the germs of disease, and carry the infective agents on their bodies to food or to other persons. The influence of *flies* in the dissemination of disease had not been fully appreciated until a few years ago. Flies alight on all kinds of filth and soil their wings and feet and may subsequently carry the disease-producing bacteria to food-materials. In this manner disease may be disseminated over considerable areas. Consequently, for distinct sanitary reasons, flies, as well as mosquitoes, should be excluded from houses by means of mosquito-netting. Similarly, *fleas* should also be destroyed or excluded, as they are thought to be directly or indirectly instrumental in the transmission of plague and of the "spotted fever" of Idaho and Montana. *Rats* are believed to be concerned in the dissemination of plague.

All vermin should, therefore, be excluded from houses, and when they have gained access, they should be exterminated as speedily as possible. Vermin of this character are found most frequently in filthy locations, and hence cleanliness is the best safeguard against vermin as well as against the diseases which they may disseminate.

The Prevention of Disease by Isolation and Disinfection.—By means of isolation the infective materials are confined to the immediate vicinity of the patient, and by means of disinfection, the infective materials are rendered harmless. The discovery of the specific causes of disease and the avenues by which they are thrown off from the body have simplified our efforts to limit the dissemination of disease through disinfection.

In the diseases of the alimentary tract the infective agents are thrown off with the intestinal evacuations and the urine, and it is to these evacuations that we must apply the disinfective materials. In diseases of the respiratory tract, as in influenza, pneumonia, pulmonary tuberculosis, diphtheria, mumps, and whooping-cough, the sputum contains the infective agents, and must, therefore, be disinfected. In these diseases the sputum should be collected in sputum-cups or paper napkins, which can be disposed of by burning them. In the eruptive fevers the infective materials are believed to be given off principally through the desquamating epithelium, and this must receive the disinfecting materials.

The individual susceptibility to infection varies greatly. The degree of susceptibility is dependent principally upon the general physical condition of the individual, upon his environment, and upon hereditary influences. *A lowering of the general physical tone*, from whatever cause, predisposes to infection. So long as the physical condition of the body is maintained in the normal state, infection does not readily take place. It is safe to assume that all of us are more or less frequently exposed to different infective agents, which fail to gain a foothold in our bodies because of the normal vital resistance. **En-**

vironment plays an important part in predisposing to infection. This may operate by inducing a lowered vitality of the body, as well as by the more frequent and intimate contact with infective materials in places that are overcrowded, as street-cars, schools, and other public assemblies. The influence of environment is brought out very well in the investigations of Anders and Flick, of Philadelphia, and Park, of New York, on the prevalence of tuberculosis in certain houses. These investigations have shown that the disease is most prevalent in houses in which previous cases have occurred. **Heredity** plays an important rôle in the individual susceptibility to disease. The peculiar constitutional states which we inherit predispose to special types of infection. This is seen in the greater susceptibility to certain diseases in one family than in another. The influence of heredity is seen more particularly in the prevalence of certain constitutional diseases, although it is believed to be an important factor in predisposing to diseases like tuberculosis and rheumatism.

Hygiene of the Sick-room.—When infectious disease appears in the household, the patient should be isolated in a large airy room on the upper floor, which is removed as far as possible from the other occupants of the house. The upper floor of the house is to be preferred, because it is further removed from annoyance by street-noises and street-dust. All well persons, with the exception of the physician and nurse, should be rigidly excluded from the room. The other occupants of the house should be prohibited from attending any school or other public assembly. A moistened sheet suspended in front of the door of the sick-room will serve to arrest most of the infectious dust-particles. The room itself should be furnished as simply as possible ; all unnecessary furniture, as well as carpets and curtains, should be removed. No sweeping should be allowed in such a room. The nurse should wipe all horizontal surfaces with a damp cloth each day. The clothing and bed-clothing should be placed in carbol-soap solution before they are removed from the room. The sick-room should be supplied with a gas-stove and a small boiler, in which napkins, eating utensils, etc., may be disinfected with boiling water before removal from the room. The food that is not consumed by the patient should always be burned.

After the recovery of the patient the room should be closed for some hours to allow all dust-particles to subside. It should then be fumigated or disinfected, after which it may be cleaned in the usual manner with hot soda solution, chlorid-of-lime solution, or some of the stronger disinfectants, as 2 or 3 per cent. carbolic-acid solution. All toys and other articles of little value which have been in the room should be wrapped in a sheet moistened with solution of chlorid of lime or carbolic acid and afterward burned. Books that have been in a sick-room should always be disinfected before they are again used. This is usually done by means of formaldehyd gas.

House-quarantine is instituted by the authorities of cities and towns against a number of infectious diseases, the custom varying somewhat in different places. The diseases against which quarantine is usually practised are : cholera, small-pox, diphtheria, diphtheric croup, membranous croup, scarlet fever, typhoid fever, typhus fever, plague, epidemic cerebrospinal fever, relapsing fever, and leprosy. The length of time during which quarantine is necessary differs with each disease : in some, the period is fixed arbitrarily ; in others, as in diphtheria and diphtheritic croup, quarantine is maintained until cultures from the patient's throat show the absence of the specific bacteria. In the eruptive fevers, as scarlet fever and measles, quarantine is continued until desquamation has ceased. Table C shows the carriers of the infection, the period of incubation, the period of desquamation, the point of entrance of the infectious agent, the excretions which are infective, the cause, the special prophylactic measures, and the preventive measures of the principal infectious diseases.

The length of time during which well persons should be detained in quarantine after exposure to the different infectious diseases which might be carried by them, is shown in the following table :

Periods of Isolation of Well Persons after Exposure to—

DISEASES.	DAYS.
Small-pox	14
Measles	10
Scarlet fever	3
Diphtheria	3
Cholera	10
Typhoid fever	14
Yellow fever	5
Chicken-pox	20
Mumps	24
Whooping-cough	21

This period of detention varies in the different diseases because of the varying lengths of their respective periods of incubation. After the period of incubation for a particular disease has passed and no new cases

TABLE C.—*Causes, Modes of Dissemination, and Prevention of Infectious Diseases.*

DISEASE.	Specific Causative Agent.	Carriers of the Infection.	Avenue of Entrance.	Period of Incubation.	Infectious Secretions and Excretions.	Personal Prophylactic Measures.	Preventive Measures.
Scarlet fever.	Unknown.	Fomites.	Unknown.	Days. 2–7	Desquamation.		Isolation and disinfection.
Measles.	"	"	"	10–16	"		"
Chicken-pox.	"	"	"	4–14	"		"
Small-pox.	Cytorrhyctes variolæ.	"	"	8–14	"	Vaccination.	Vaccination, isolation, and disinfection.
Erysipelas.	Streptococcus pyogenes.	Fomites, and direct contact.	Skin.	2–5	"		Isolation and disinfection.
Mumps.	Unknown.	"	Respiratory tract.	10–15	Sputum.		"
Whooping-cough.	"	"	"	7–14	"		"
Diphtheria.	Bacillus diphtheriæ.	"	"	3–5	"	Administration of antitoxin.	Antitoxin, and isolation and disinfection.
Influenza.	Bacillus influenzæ.	"	"	2–3	"		Isolation and disinfection.
Pneumonia.	Micrococcus lanceolatus.	"	"	1–3	"		"
Tuberculosis.	Bacillus tuberculosis.	"	"	Several weeks or months.	"		"
Leprosy.	Bacillus lepræ.	"		"	Secretions.		"
Plague.	Bacillus pestis.	"		Days. 3–6	"		Extinction of rats and fleas, isolation and disinfection.

Cerebrospinal fever.	Micrococcus intracellularis meningitidis.	"		Unknown.	"		Isolation and disinfection.
Cholera.	Spirillum choleræ.	Infected food and water.	Digestive tract.	Days. 2-5	Feces.	Boiling of water and food.	"
Typhoid fever.	Bacillus typhosus.	"	"	12-14	Urine and feces.	"	"
Dysentery.	Bacillus dysenteriæ.	"	"	2-3	Feces.	"	"
Tetanus	Bacillus tetani.	Infected soil and dust.	Abrasions and wounds.	3-30	Secretions.		"
Anthrax.	Bacillus anthracis.	"	"	1-3	"		"
Glanders.	Bacillus mallei.	"	"	3-4	"		"
Malignant edema.	Bacillus œdemæ maligni.	"	"		"		"
Syphilis.	Unknown.	Contact.	Skin and mucous membrane.	About 3 weeks.	"		"
Gonorrhea.	Micrococcus gonorrhœæ.	"	Mucous membrane.	Days. 3-5	Pus.		"
Typhus fever.	Unknown.	Fomites.		5-14			"
Relapsing fever.	Spirillum obermeieri.	Insects.	Local.	8-12		Protection from bedbugs.	"
Yellow fever.	Unknown.	Mosquitoes.	"	3-6		Protection from mosquitoes.	Isolation of patient from mosquitoes and destruction of all mosquitoes.
Malaria.	Plasmodium malariæ.	"	"	6-16		"	"

have developed, the persons in quarantine may be released.

Special Precautions against Typhoid Fever.—The following is an open letter relative to the prevention of typhoid fever, issued to the citizens of Philadelphia by the Bureau of Health:

Typhoid fever is caused by a tiny germ that gets into the body of the sick person, usually by way of the mouth, and that escapes from the body with the discharges from the body.

The discharges are, therefore, to be regarded as dangerous. These matters may easily be rendered harmless by scalding them with boiling water or by the use of any of the reliable disinfectants, especially chlorid of lime. Such matters should always be disinfected before being thrown away.

When discharges from typhoid patients are thrown into wells or strewn upon the ground or into sewers, the germs do not die at once, but remain alive for varying lengths of time, and when spread about, may cause an outbreak of the disease.

Persons contract typhoid fever principally by swallowing germs that have come from some case of typhoid fever; sometimes the germs are conveyed to the mouth on soiled hands. This is most frequently seen in the cases of careless nurses who are in attendance upon typhoid patients. Sometimes they get into the drinking-water, where they may live for a time, and cause the disease in those using the water.

Sometimes they get into milk by way of water that is used in washing the milk-cans and bottles. When present in milk, they grow and multiply with great rapidity, and a number of serious outbreaks of the disease have been traced to milk in which these germs were growing.

Now and again oysters that are kept in water that is polluted with sewage are also known, when eaten raw, to have caused the disease. It is also possible that typhoid fever is sometimes spread through other food-stuffs on which the germs have been by accident or through carelessness deposited.

Fortunately, the germ of typhoid fever is easily killed by heat. If water or milk containing living typhoid germs be boiled for one minute, they are rendered free of danger, as such treatment kills all living germs. The cooking of other foods robs them also of all power to cause typhoid.

When typhoid fever is present in a neighborhood, much may be done to check its spread by the use of only boiled water and milk and cooked foods. After water, milk, and other food-stuffs have been freed from danger by cooking, they are to be protected against the dust and dirt until used.

Special Precautions against Small-pox.—A valuable circular relating to the prevention of small-pox epidemics, issued by the Bureau of Health of Philadelphia, reads as follows :

Small-pox is one of the most contagious of diseases. It is probably contagious from the beginning to the end of its course.

The majority of persons who have not been successfully vaccinated or who have not had small-pox are liable to contract it when it is present in the community.

Of persons who have had the disease or those who have been successfully vaccinated within a period of five years, only a very small number are ever attacked.

Before the beneficial effects of vaccination were discovered small-pox was one of the commonest of diseases. Rich and poor, high and low, ignorant and educated, were all affected. In those countries where vaccination is compulsory, small-pox is to-day regarded as a medical curiosity.

It is a significant fact that of all the cases of small-pox admitted to the Municipal Hospital of Philadelphia only a very small number have been children attending the public schools. The reason for this is that no child is allowed to enter the public schools who has not been vaccinated.

No one should regard himself as protected from small-pox until a physician has pronounced the vaccination a success. A sore arm or the simple act of vaccination does not necessarily constitute protection.

When a case of small-pox occurs, it is for the best interest of the patient, the family, and the county for the patient to be removed at once to the Municipal Hospital for treatment. When for various reasons this is not done, he should be isolated in a room on the upper floor of the dwelling, located as far as possible from those rooms occupied by the rest of the family. The room should be instantly cleared of all carpets, curtains, hangings, and unnecessary woolen goods. The furniture should be of the simplest possible description. The simpler the furnishing of the room, the more easily can successful disinfection be accomplished after recovery of the patient.

When the room occupied by the small-pox patient has been vacated, the Board of Health should be notified. The premises will then be disinfected and all articles of bed and body clothing will be removed to the disinfecting plant, and, after having been rendered free from danger by exposure to steam, will be returned to the owner. This is done without cost to the householder and without injury to the articles.

Under no circumstances should bed or body clothing or room hangings be taken from the sick-room to other parts of the house or be shaken out of the window until after they have been properly disinfected. By so doing the disease is spread through the house or through the neighborhood.

When small-pox has occurred in a house and after the sick-room has been disinfected, nothing is more useful in rendering the premises free from danger than a thorough scrubbing of walls, ceilings, floors, and furniture with a hot solution of common washing-soda made by mixing one-half pound of soda in three gallons of boiling water.

Persons renting houses in sections of the city where small-pox has been conspicuously prevalent would do well to inquire into the health of the family last occupying the premises.

Employers would do well to insist that all employés present a physician's certificate of successful vaccination.

All suspicious eruptions upon the skin should be at once submitted to a physician for examination. In case of doubt the Board of Health stands ready to offer the services of physicians skilled in the recognition of small-pox.

Too much stress cannot be laid upon the desirability of prompt notification in connection with small-pox. On a number of occasions the work of the Board of Health in eradicating the disease has been seriously hampered by failures and delays in carrying out this obligation.

APPENDIX.

PULSE, TEMPERATURE, AND RESPIRATION.

The pulse, temperature, and respiration are called the "*three vital signs*"; and it is of advantage to every one to understand them and to recognize the variations from normal and their significance. They are so closely connected that whatever affects one generally affects the others.

The Pulse.—Each time the heart contracts, blood is thrown into the arteries, distending them; and it is this distention, or rising-up of the wall of the artery at regular intervals, corresponding with the beatings of the heart, that is called "the pulse." In feeling the pulse we should determine its frequency, its force, its fulness, and its regularity. Position and action alter the pulse-rate; for instance, it is generally faster in standing than in sitting, and faster in sitting than in lying down; it is slower in sleep, and faster toward death; it is slower in old age than in middle life, slower in men than in women, faster in children than in adults, and faster during excitement or exercise.

To take the pulse, two or three fingers should be placed on the radial artery at the wrist or on the temporal artery just in front of the ear, counting the pulsations preferably for a full minute, or for at least a half minute, multiplying the result by two. The thumb should not be placed on the artery, because this method is awkward, and also because the pulsations of the artery in the thumb are frequently so readily perceptible as unconsciously to lead one to determine his own pulse-rate rather than that of the patient.

The pulse-rate	in the infant	at birth is from	130 to 150	a minute.
"	"	at 1 year is from	110 to 130	"
"	"	" 2 years "	90 to 115	"
"	"	" 3 " "	80 to 110	"
"	"	" 7 " "	72 to 90	"
"	"	" 12 " "	70 to 76	"
"	"	in early adult life is from	70 to 75	"
"	"	" late " " "	65 to 70	"

In very old age the pulse-rate may increase slightly; and there are instances in which the normal adult pulse-rate is rather high, while in others it may be persistently as low as from 45 to 60.

Body-temperature.—The normal temperature of the human body in adults is 98.6° F., with slight variations for different constitutions, the time of day, age, mental state, relation to meals, etc. It is often slightly higher in children, and subnormal in advanced age. The body-temperature gradually rises during the day, and is supposed to reach its maximum between 5 P. M. and 8 P. M., and its minimum between midnight and 4 A. M. It is commonly slightly elevated after a full meal, exercise, or strong emotions, especially in children or hysterical adults. Profuse perspiration tends temporarily to lower the body-temperature. Body-temperature persistently below 95° F. or above 108° F. is likely to be followed by death. There is a definite relation between the pulse-rate and the temperature, the pulse commonly increasing from eight to ten beats with each additional degree of temperature. A sudden and marked rise or fall of temperature should give warning of the necessity of immediately summoning a physician, as it is usually indicative of serious illness. However, sudden changes of temperature without great harm are frequently noticed in children and in hysterical persons.

Taking the Body-temperature.—The temperature of the body is taken with a clinical thermometer in the mouth, the axilla, the groin, the vagina, or the rectum. The temperature of the axilla is about half a degree lower than that of the mouth. The temperature of the rectum and of the vagina is about half a degree higher than that of the mouth, because these cavities are constantly closed.

For convenience, the temperature is generally taken in the mouth. The thermometer is washed in cold water and wiped dry, the mercury is shaken down to 95° F., and the bulb of the thermometer is placed under the tongue and the lips kept closed for five minutes. The patient must be told not to open the lips while the temperature is being taken, or cold air will enter the mouth and the instrument will register a temperature lower than it should. Hot or cold drinks given immediately before taking a temperature in the mouth will make the recorded temperature correspondingly higher or lower. After each application the thermometer should be carefully washed with soap and water and alcohol and sterilized with some harmless disinfectant.

Respiration.—The normal number of respirations in an adult is 16 to 18 a minute—one to four beats of the heart. In children of both sexes and in man the breathing is chiefly *abdominal* and in women it is chiefly *thoracic*. When taking the respirations, one should notice if they are regular or irregular, frequent, quiet, deep, shallow, thoracic, or abdominal. The respirations can be counted by watching the rise and fall of the chest after having taken the pulse, the fingers being still on the wrist. The most accurate way is to lay the hand lightly on the chest, but there is the danger of the patient breathing slower or faster when he knows the respirations are being counted. It is always best to count the respirations when the patient is asleep, as they are then slower, but natural. Respirations are increased by excitement and exertion. The respirations in infants are from 30 to 35; at the fifth year, from 20 to 25; after the eighth year they are the same as those of an adult.

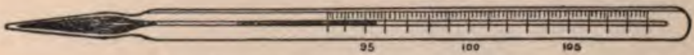

FIG. 99.—Clinical thermometer.

BATHS.

The temperature of baths varies, and the water must be tested with a bath-thermometer (Fig. 100). A hot bath varies from 98° to 110° F.; a warm bath varies from 85° to 98° F.; a tepid bath varies from 70° to 85° F.

A bath must never be given sooner than two hours after eating, for the reason that after eating, the digestive organs, as a rule, are congested, owing to the increased activity with which they are obliged to do their work in the process of digestion.

Hot-baths.—Hot baths and **vapor**-baths are given to produce perspiration. If a tub-bath is ordered, the tub may partly be filled with warm water, and then the temperature gradually increased by adding very hot water. At the end of fifteen minutes the bather is wrapped in blankets, which are tucked in very securely about the neck and body, so that no air can enter. Cold cloths may be applied to the head, and water is given to drink, because when there is a large quantity of water in the body, the perspiration becomes much more profuse, and consequently the impurities thrown off are larger in amount. After the bath is completed, the blankets are removed and the patient may be sponged with warm water or with alcohol and water.

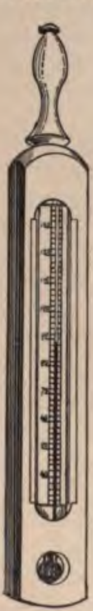

FIG. 100.—Bath-thermometer.

Hot Foot-baths.—The temperature of the water should be kept even by adding hot water. The bed-clothes at the foot of the bed are loosened, a newspaper or a rubber cloth is spread across to prevent the bed from getting wet, the bather's knees are drawn up, the feet are placed in the tub, and the clothing is drawn about the limbs to prevent chilling. When taken out, the feet are to be wiped dry, care being taken that they are comfortably warm either by wrapping them in a blanket or by applying heaters.

Hot-vapor Bath.—A rubber cloth or an oilcloth and blanket are put on the bed (the bather being turned on one side, as is done in changing the bed); the clothing is removed, and the bather is then wrapped snugly in the blanket, the upper clothing being supported by means of a cradle. The clothing should be well tucked in about the neck and the sides of the bed, under the mattress, to prevent the escape of air, and another oilcloth put over all will make the covering much more air-tight. Under the clothing, at the foot of the bed, is inserted the spout of a kettle of boiling water, which can stand over a gas- or an oil-stove or a spirit-lamp placed on a chair or a table, the whole being covered with a blanket to direct the steam under the blankets (Fig. 101). If the bed has a high foot-board, the steam can be directed from one side of the foot of the bed. The attendant should guard against fire. This bath should be given only under the direction of a physician, who will give orders as to the length of time the bather is to remain in the bath. A thermometer is to be placed in the bed, and the steam continued until the thermometer registers 120° F. or above, when the steam is stopped and the bather is treated as after the hot bath. As the water in the kettle boils down it must be replaced by *boiling* water, not by hot or cold water, or the steam will stop until the water boils again. Careful watch must be kept over the bather's pulse, which can be taken at the temples.

In the absence of an oil-stove or a spirit-lamp, very hot bricks, smoothing-irons, or plates may be wrapped in wet flannel or cloths; the hot bricks in contact with the wet cloths will make steam. The cloths must be placed about the bather on plates or in dishes to prevent wetting the bed, and care be taken not to burn the bather. The bather may also be seated on a cane-bottom chair, the clothing being removed, and surrounded with blankets or comfortables, which must be fastened from the neck down (Fig. 102). A kettle of boiling water over a spirit-lamp or an oil-stove, or a pan or pail of boiling water, is placed under the chair. The feet may be put into a pail of hot water to increase the effect, because the blood-vessels of the surface of the body are dilated, and remain so while the heat or vapor is continued; in this way the activity of the skin is increased, the pores of the skin are opened, and perspiration is produced. The attendant should be sure that the blankets or coverings are fastened closely around the neck and about the chair to prevent the steam escaping. Cold is applied to the head, and water is given to drink, for the same reason as that given in describing the hot baths, and the after-treatment is the same.

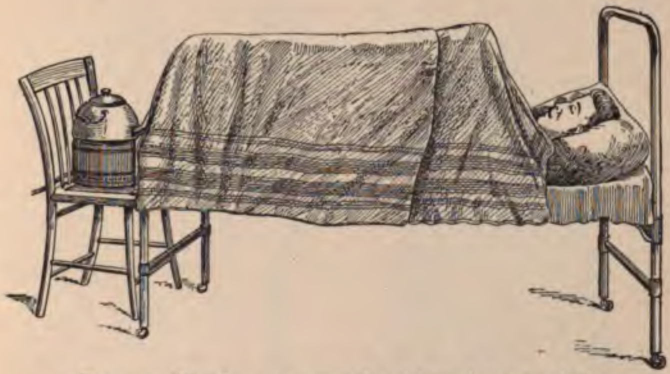

FIG. 101.—Simple arrangement for giving a hot-vapor bath.

Hot-air Bath.—The general details of giving a hot-air bath are the same as those for giving a hot-vapor bath, with the exception of the use of water to generate steam. The hot air is generated by means of an alcohol-lamp or an oil-lamp, and it is conveyed to the bed and beneath the clothes by means of an elbow of stove-pipe.

Acid Steam-bath.—An acid steam-bath, which is a valuable application in rheumatism, is given by preparing the patient in the usual manner, and placing about her very hot bricks wrapped in flannel which has been steeped in vinegar. The bath is continued for fifteen minutes, after which the body is wiped over with a towel wrung out of cold water, then thoroughly dried.

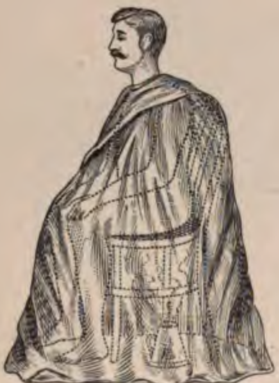

FIG. 102.—Arrangement of blankets in giving a hot-air bath to patient in sitting position. (Thornton.)

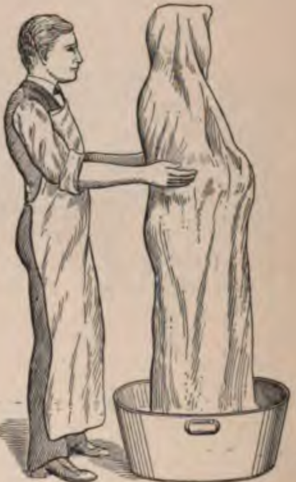

FIG. 103.—Application of the sheet-bath (drip-sheet).

The sheet-bath, or drip-sheet, which is frequently applied in nervous diseases, is generally given in the following way: The bather, with clothing removed, stands in a tub which contains enough warm water to cover the feet to the ankles to prevent chilling (Fig. 103). A sheet wrung out of tepid water is thrown over the patient from behind, and covers the head and entire body. The bather is then gently rubbed (over the sheet) with both hands to produce friction and bring the blood to the surface. As the sheet becomes warm it can be rewet by pouring water on it from a cup or a bowl. The physician will always give directions as to the length of time the patient should be in the sheet. After being dried, some physicians like their patient to be put to bed for a certain length of time, while others will leave orders for the patient to dress and go out for a short walk or to sit by an open window.

The cold douche, or affusion, is given by wrapping the bather in a sheet, placing him in the bath-tub, and pouring pailfuls of water over the body. The first pailful should be tepid, and be poured rather slowly, to prevent shock. Exhaustion must be watched for, and after the affusion the patient should be put to bed and wrapped in blankets. Another way, one often employed in nervous diseases, is to stand the bather in the bath-tub, and direct the water to the spine or to the part to be treated, by a piece of hose-pipe attached to the faucet.

The cold pack is ordered for reducing the temperature in many acute diseases. A rubber, an oilcloth, or a newspaper is first put on the bed, and over this one or two blankets; then a sheet or a table-cloth which has been dipped in cold water and wrung out is placed on the blankets. The patient is laid upon the sheet (the clothing having first been removed), and every surface of the body is covered by pressing the folds of the sheet down between the arms, body, and lower extremities. The sheet is tucked well in at the neck and feet; the blankets are then folded over and tucked evenly under the patient on both sides. The feet are lifted up, and the corner ends of the sheets and blankets are tucked under them (Figs. 104 and 105). A wet towel or compress is applied to the head. The patient should be kept in the pack ten or fifteen minutes. Besides lowering the temperature, the cold pack will often relieve nervousness and induce sound sleep.

The hot pack is given in the same way as the cold pack, with the exception that the blanket, the sheets, or table-cloth is wrung out of boiling water by placing the blanket in a sheet and pouring the boiling water over them; two persons, each taking an end of the sheet, wring in opposite directions. More coverings are placed over the patient than in the cold pack. Should the attendant not have anything with which to prevent the mattress from getting wet, a table may be arranged with blanket and sheets; in the absence of a table, the floor near the bed may be prepared. Towels, tablecloths, and old linen may be used where there are but few sheets. After the pack the sheets and blankets are removed, the patient is wiped dry with soft towels, the clothing is put on, heat is applied if necessary, and the pulse and temperature are taken. **Partial packs** are compresses applied to different parts of the body, and covered with a flannel or a

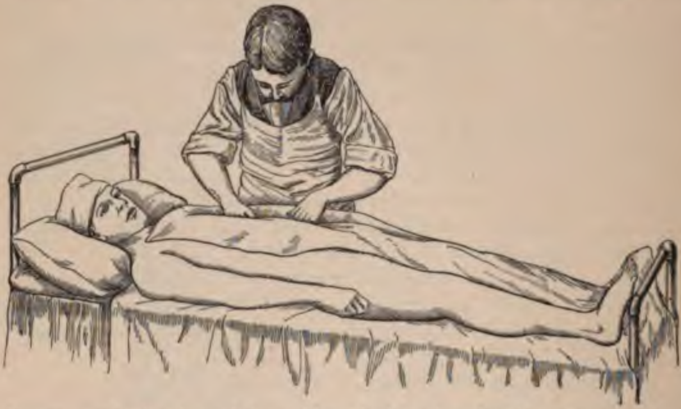
FIG. 104.—Application of the cold pack (pressing the sheet between the patient's arm and body).

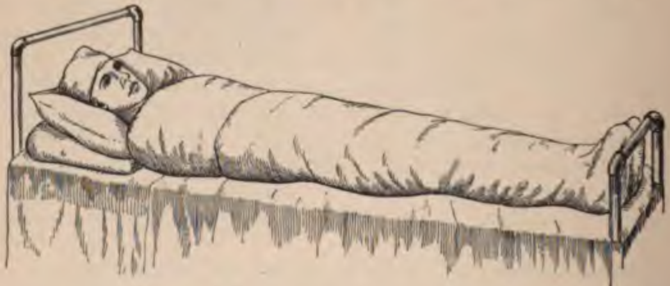
FIG. 105.—Application of the cold pack (patient completely covered, with wet towel on the head).

cotton bandage to prevent the patient's clothing becoming damp.

MASSAGE.

The value of massage lies in the stimulation of the peripheral nervous system, the increased tonicity of the circulatory system, particularly the vasomotor apparatus, the aiding of metabolism, and the exercise and development of muscles, without exhaustion of the central nervous system. Besides these advantages, the soothing influence of the rubbing itself is of great benefit to persons who are nervously exhausted. The special uses of massage in the treatment of disease are not within the scope of this work.

General Rules.—The person administering massage should have soft, clean, warm, and dry hands. A general rub should be given about bed-time, and should last from one-half to one hour. Massage should not be administered for an hour after a meal. Contraindications are fever, enlarged veins, tumors, pregnancy, and when, as rarely happens, it irritates rather than soothes. Massage in the day-time should be followed by an hour's rest.

Several special methods of movements have been devised, but, as a rule, the claims for them are delusionary. The simple common-sense method of rubbing outlined by Dr. F. S. Pearce,[1] and given in the following paragraphs, contains the most important movements found in the several "special schools."

The movements of massage are :

1. *Effleurage*, the gentle surface stroking of the part, which quietly starts the circulation before the more vigorous rubbing begins.

2. *Friction*, which consists in a firmer and deeper pressure-rub than the preceding movement.

3. *Pétrissage*, which is a very deep kneading of the part, and completes what has been begun by 1 and 2. It is essential in pétrissage to hold firmly to the skin, and to make this rub the subcutaneous tissues, while the last in turn presses the muscles, and so on until the soft parts are so manipulated, squeezed, and pressed against the bones of the patient that a veritable pushing-on of all the liquids (blood and lymph) takes place ; also, indeed, of some of the semisolids, which become disintegrated, and their ultimate particles are swept

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[1] *International Medical Magazine*, February, 1902.

on in the hurried circulation to be oxidized or converted into energy, or to be excreted, instead of remaining in the body as sources of irritation in the form of what we call leukomains.

4. *Tapotement,* or tapping in a rapid, vibratory manner with the balls of the fingers of one or both hands held gently closed, similar to the position of holding a pen. This movement is not so very essential, but is sometimes used as a final stimulator of the circulation when it is extremely sluggish.

The foregoing manipulations are followed with effleurage, shading off into very gentle strokings which are soothing to the part and to the patient generally, while they also equalize the blood circulating in the superficial tissues.

Method.—The subject is required thoroughly to relax all his muscles, and is then placed on his right side. The manipulations are begun on the left foot, toes, ankle, thigh, hip, and buttock, in turn; using all the movements described over each part, varying the time and duration of each in proportion to the size, rigidity, and amount of muscle or other soft tissues present. The patient is then asked to turn toward the opposite side, and the right foot, leg, thigh, and buttock are rubbed in the same thorough fashion.

Next the left fingers, forearm, arm, and shoulder are first given the long, sweeping effleurage, followed again by the rest of detailed movements described; but the eye has to follow quickly to appreciate the rapid changes, so much a part of the manipulator does the patient become. Four or five minutes will suffice, and the right arm is now taken up. After this the patient is requested to lie on his abdomen, and a pillow is placed under him for better resistance. The long series of strokings down the vertebral gutters are made alternately with the fingers of each hand spread on either side of the spinous processes. Then comes a series of circular frictions down each recti group with one hand; then a spreading movement from the spines outward with the balls of both thumbs; next a firmer pétrissage with both hands; followed by that motion with the palms of both hands alternately run down either side of the spinal column, giving a delightful sensation; while the final effleurage finishes and the patient is requested to turn on the broad of his back, the pillow being removed.

The chest movements consist principally of two: a firm stroking, following the ribs from the sternum out and down; and of firmer pétrissage, in which the balls of both thumbs play an important rôle and can be so dexterously done as to be not at all painful, which occasionally happens with the beginner.

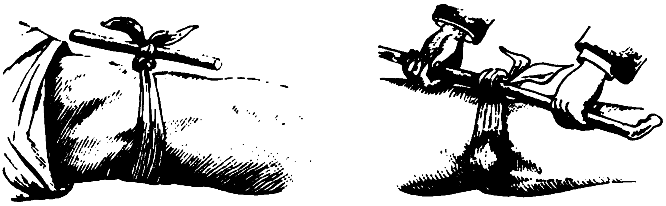
The abdomen rubbing is very important and difficult of performance: The thighs are flexed on the abdomen and legs on the thighs in order to relax the anterior abdominal walls. The effleurage is simple, but it requires tact to knead thoroughly without tickling. This should be begun over the small intestine, working with both hands in a "spanning"-like manner. Then start at the head of the colon, and work along the ascending, transverse, and descending portions, one hand following the other in rotary motions. Again effleurage follows, and if there is constipation, that series of rapid vibrations described will aid much toward the cure. As a rule, the face, head, and neck are not rubbed in ordinary work. When specially requested, this is done by a series of strokings and kneading movements in the direction of the venous circulation. In all movements the greater pressure should be from the periphery toward the heart—*i. e., centripetal* in character.

ACCIDENTS AND EMERGENCIES.

A cut or incised wound is made by some sharp cutting instrument. If deep or extensive, or if bleeding very freely, it should have surgical attention at once. A small cut should be washed gently but thoroughly with absorbent cotton and cold or very hot water (which will both cleanse it and help to arrest the bleeding) and then with an antiseptic solution. A compress made of clean folded linen or muslin wet with the solution should now be placed over the wound and bound on, not too tightly, with a roller bandage. If the bleeding will not stop, the bandage must be applied with moderate firmness, or pressure be made with a finger. If the blood spurts out of the wound in jets, an artery has been injured. Bleeding from this or from any other wound can always be stopped until a physician arrives by making pressure with the fingers directly into the wound. The pressure must be constant, and not relaxed every few minutes to see if the flow has ceased. The use, by others than physicians, of what is called a *tourniquet* —such, for instance, as a twisted handkerchief (Fig. 106) or a cord tied tightly around the arm or the leg—is not only very painful, but is dangerous also, since it may cause serious sloughing and death of the tissues.

When a finger is cut off, it should be immediately washed carefully, and fastened firmly in place again with adhesive plaster, and a physician sent for. It sometimes happens that the severed portion will grow fast.

A tear, or lacerated wound, is produced by some dull body, such as a nail or a brick. It has ragged edges and does not often bleed much. Unless very small, a physician should treat it, since wounds of this sort are more likely to leave scars. A small tear must be cleansed carefully with lukewarm water, followed by an antiseptic solution, as it is very apt to have dirt in it. The torn edges should be brought together as well as possible, and the wound covered with a compress wet with the antiseptic fluid and bandaged up loosely.



FIGS. 106, 107. Impromptu tourniquets for compressing an artery with a handkerchief and a stick.

Punctured wounds are those made by sharp-pointed objects, such as pins, needles, fish-hooks, tacks, splinters, and the like. They are often painful and attended by a good deal of swelling. The object must be removed and the injured part squeezed gently in warm water in order to favor the flow of blood, which will help to wash away the impurities which may have entered. If there is a tendency to swelling, a warm antiseptic poultice may be applied.

In case a **needle** has entered and remained in the flesh, great care should be taken not to break it in attempting to remove it, and it should be closely examined after removal to see that it is quite intact. If it has been broken, a surgeon must be called in and the fragment saved to show him.

Fish-hooks which have entered beyond the barb must be cut out or be pushed through the skin from inside, either, but never torn out.

If any portion of a **splinter** is protruding, it may be seized with small pliers or tweezers and pulled out, care being taken to avoid any side motion, lest the wood break off. If it cannot be removed in this way, it may, perhaps, be picked out with a needle. Should a splinter too short to grasp have lodged beneath the finger-nail, the nail should be carefully scraped very thin over it and then be split open with the point of a sharp knife, just enough to allow of the top of the piece of wood to be seized. This should be done under antiseptic precautions and, if possible, always by a physician.

Insect-stings belong to the class called poisoned wounds. They are seldom dangerous, although for a time quite painful. Careful examination may show the sting of the insect still in the wound. It should be pulled out with tweezers, and water of ammonia or spirits of camphor applied. A cold-water dressing may then be employed to prevent swelling. The application of mud is useful.

Mosquito-bites are often a source of great annoyance and disfigurement. The annoying itching may be allayed by touching the bites with carbolized oil, ammonia, or spirits of camphor, or with a cooling evaporating lotion. Dampened salt rubbed on the spot is sometimes useful.

Dog-bites or the bites of other animals, as the **cat or rat,** are sometimes productive of severe inflammation, and even of decided illness. It is rare, however, that hydrophobia follows. The dog which has bitten any one should on no account be killed until it has been kept long enough to determine whether or not it was mad. To find that the animal was not rabid will be a great relief to all concerned. Wounds produced by the bite of an animal should be pressed out thoroughly under warm water or be well sucked. They may then be covered with a cold wet dressing. The patient should seek medical aid immediately; and if the bite is that of a dog undoubtedly mad the part must be cut out quickly, or be cauterized deeply with a red-hot iron or with strong carbolic or some mineral acid, such as sulphuric or nitric.

Snake-bites constitute a variety of poisoned wounds fortunately not often met with in this part of the world. If the snake was a venomous one, a cord should at once be tied around the limb above the wound to stop the progress of the blood and to keep the poison out of the general circulation.

The wound should be squeezed out under water, or may be sucked thoroughly, provided the lips of the person who does this are quite free from cracks. Medical assistance should be summoned at once, and the wound ought to be cut out or cauterized, as in the case of dog-bites. Stimulants in large quantity have been recommended, and are perhaps of service. A solution of permanganate of potash of the strength of 20 grains to the ounce should be used to wash the wound.

Ivy Poisoning.—The intolerable itching may be relieved by plain water, baking-soda and water, lime-water, lead-water and laudanum, grindelia robusta, etc.

Bruises or contusions generally do little damage other than temporarily to disfigure. A painful swelling develops, rapidly increases in size, and turns deep purple as the result of the escape of blood under the skin. This color gradually passes through different shades of green and yellow until the blood has been absorbed. To prevent the swelling and discoloration to any degree, the treatment must be begun at once. Firm pressure may be kept up, or compresses wet with ice-water, very hot water, or alcohol and water continuously applied. The colorless fluid extract of witch-hazel put on at once on a compress is excellent treatment. If discoloration has occurred, its disappearance may be hastened by rubbing the bruise with some bland ointment like lanolin.

Sprains.—A twisting or straining of a joint, or a sprain, produces great pain on motion, rapid swelling, and often a discoloration of the skin like that of a bruise. Although in many instances sprains are slight and are quite well in a few days, in some severe ones recovery is very slow and the bad effects are more lasting than in the case of broken bones. Recent *x*-ray photographs of obstinate sprains have demonstrated coincident fracture of a neighboring bone. Every sprain except the very mildest should have a physician's attention as early as possible. If this cannot be procured, the joint should be soaked for from twenty to thirty minutes in very hot water and then be put at absolute rest. If it is the ankle or the knee which is injured, the patient must be kept in bed, with the part elevated and covered with a dressing of cold water or of witch-hazel. In the case of the arm, the joint must be kept quiet on a pillow or supported on a splint or in a sling with the dressing applied. After the acute pain and all signs of inflammation have disappeared,—which is often a matter of days or even of weeks,—the joint may be rubbed daily with soap liniment or chloroform liniment and very carefully and slightly moved. Under the special supporting dressings which surgeons employ, the confinement to bed after sprains of the lower extremities is greatly curtailed.

Fractures.—A single break in a bone without injury to the flesh is called a *simple* fracture. If the flesh is injured, the fracture is called *compound*, and is of a much more serious nature. A *green-stick* fracture is one in which the bone is bent and only partially broken. It occurs chiefly in children. The management of a fracture before the arrival of the surgeon consists in securing perfect rest. If a leg be broken, the patient should be laid on a stretcher, a door, or a shutter, and a splint may be improvised with an umbrella, a walking-stick, a thin board, books, newspapers, or a coat rolled up and tied to the side of the leg with handkerchiefs above and below the break. If none of these articles is at hand, the legs may be tied together. Clothes should not be torn, but opened at the seams. To remove boots, one hand should be placed at the ankle to steady the limb. If the foot is injured or there is much pain, the seam of the boot may be cut. Great care should be taken to prevent further injury to the limb by rough handling. If there is much shock, heat should be applied and stimulants administered.

Dislocations consist in the displacement of the bone or bones of a joint by some external violence, such as a fall or a blow. The patient should be put to bed on his back, the part bandaged, and ice applied to prevent inflammation, and a surgeon summoned.

Dislocation of the **lower jaw**, which is sometimes caused by yawning, can generally be overcome by wrapping the thumbs in a handkerchief and placing them in the patient's mouth on the lower back teeth and pressing down and back, when the bone will generally slip into its place.

Handkerchief bandages (Figs. 108–111) are very useful in emergencies. They consist of large handkerchiefs or of pieces of linen or muslin, each 32 inches square. The **triangle** is made by cutting the square diagonally, so that two three-cornered pieces are the result. A **cravat** is made by folding in the sharp corner toward the base of the triangle until a bandage about 3 inches wide is formed.

The four-tailed bandage (Fig. 112) is useful for dressings about the face (Fig. 116), the scalp (Figs. 114, 115), and the knee.

A many-tailed bandage (Fig. 113) is applied to a limb which requires frequent dressing, and consists of a piece of linen or muslin the length of the limb and wide enough to go one and one-half times around. The muslin is torn from each side, in strips about 2 inches wide, to within about 3 inches of the middle. The central part is placed under the limb, and the tails are drawn to the front over the dressing and tied; beginning at the lowest pair, the ends are brought up and the next pair tied over them.

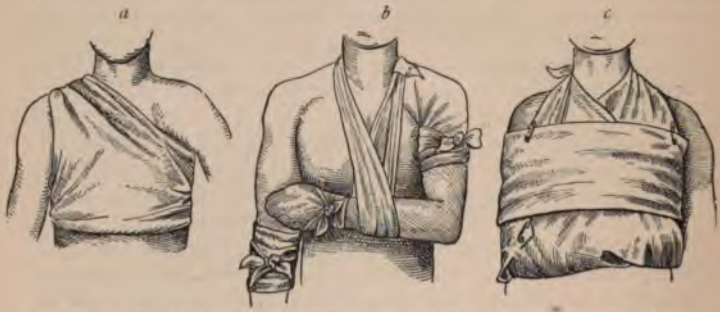


FIG. 108.—Various forms of handkerchief bandages: *a*, for the chest; *b*, for the shoulder, hand, and arms; *c*, double bandage to prevent motion of the arm.

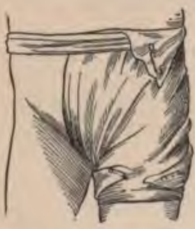


FIG. 109.—Handkerchief bandage for perineum and hip.

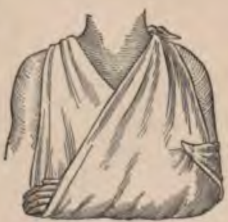


FIG. 110.—Three-cornered bandage for arm.

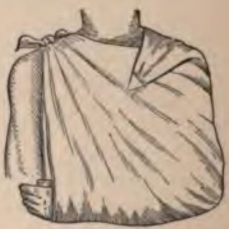


FIG. 111.—Four-cornered bandage for arm.

Burns and Scalds.—A *burn* is the result of contact with a flame or with dry heat of some sort, while a *scald* is produced by a hot fluid. For convenience, we may call them both burns, for the injury to the tissues is the same in each, except that the damage from hot liquids is apt to be less deep. The danger to life from a burn depends more upon its extent of the surface than upon its depth. On the other hand, the degree of subsequent deformity depends upon the depth of the injury. If half of the surface of the body is involved, the result is nearly always fatal. In the more superficial burns the skin is reddened and perhaps blistered, while in the deeper ones it is yellowish-white or blackened. The pain is usually very severe, yet in the worst cases the patient may suffer very little, but be so alarmingly prostrated by the shock that death follows in a few hours.

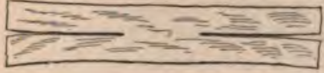


FIG. 112.—Four-tailed bandage.

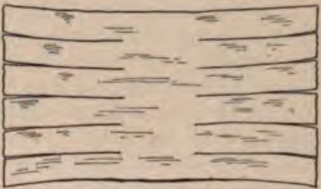
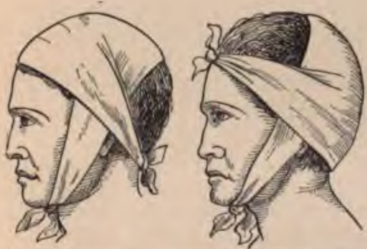


FIG. 113.—Many-tailed bandage.

When the clothes are on fire the head should be placed low, for the flames naturally tend to rise, and burns about the head and hands are the most disfiguring. Burning clothes should be wrapped about with some thick woolen material, such as a piece of carpet, a rug, table-cover, dress-skirt, shawl, or overcoat, beginning always at the neck. Cotton and linen



FIGS. 114, 115.—Four-tailed bandage for the head.

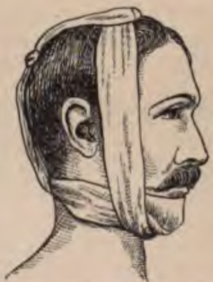


FIG. 116.—Four-tailed bandage for the jaw.

articles catch fire too easily themselves, but even these are better than nothing, for if quickly applied they may smother the flames before they are ignited. Nothing can be better than a tub or bucket of water dashed over the patient, if this happens to be at hand. Running about the room or into the open air only fans the fire.

The treatment of burns and scalds consists in first attending to the shock by the application of heat to the body, or, if possible, in giving a hot bath (temperature, 100° F.), the administration of stimulants (alcohol or black coffee), and the application of a mustard-plaster over the heart. The clothing is to be removed gently, being cut if necessary. If the burn is slight and no blisters have formed, the part is to be dressed with a saturated solution of ordinary baking-soda or dusted with baking-soda, flour, or starch, and the air excluded, because air is an irritant. The blisters may now be pierced at the edge with a clean needle, which has been sterilized by holding it a moment in the flame, and the burnt parts covered with soft linen cloths saturated with boric-acid lotion or the boric-acid ointment. Lastly, the whole should be enveloped in raw cotton, oiled silk, or paraffin paper, and bandaged loosely in order to exclude the air still more perfectly. Hot bottles should be applied to portions of the body which have not been burnt if the prostration continues. The after-treatment must be managed by a physician.

Burns with acids should have the liquid washed away quickly with water, or, still better, with a solution of baking-soda.

Burns with alkalis, as **lye,** should be treated quickly with vinegar and water. The burns may then be dressed with oily applications, such as olive oil, vaselin, or zinc ointment.

The inhalation of steam or the **drinking of scalding liquids** may cause edema, or dropsy of the glottis. Edema is a pouring-out of the watery part of the blood into the tissues, and the effusion may increase with great rapidity. Death by suffocation may occur within a very short time. The symptoms of edema are gradual loss of voice, difficulty in breathing, and blueness of the surface of the body (cyanosis) from insufficient oxidation of the blood, gasping respirations, and a flickering pulse. As an artificial opening into the trachea, or windpipe, may be demanded, a surgeon should be summoned immediately.

"What to do in case of fire" is the title of a very timely editorial in the *Independent*, May 14, 1904, based upon some recent suggestions to householders by Fire Chief Coots, of Indianapolis, Ind. The first essential is calmness and deliberation, instead of the ordinary and totally unnecessary excitement, terror, and recklessness.

The fire victim should make certain that a fire alarm has been turned in. When an alarm is sounded in good faith, the department has no complaint to make because it happens that its services are not needed. It is better for it to get there too soon than too late. The inside door of the burning building should be tightly closed. So also with the outside doors and windows. When this much has been accomplished, it is best to wait the coming of the firemen. They ought to arrive within two or three minutes under ordinary circumstances. Some one should be ready to point out exactly where the fire is and the best way of reaching it. In a large number of cases, fires start in the rear of dwelling houses, usually, it may be said, from the kitchen flue, or else from the furnace, which is frequently located under the dining room. Through the device of shutting the doors of the several rooms, both up and down stairs, the flame and smoke are prevented from spreading through the house. In many cases the fire department is thus able to confine the mischief to the original room in which the fire originated. If the inmates of the burning house have given timely alarm, and carefully attended to the foregoing, there is but little danger of a general spread of the fire.

It has happened more than once that the department has been seriously handicapped by attempts made by the family to save household goods and trinkets. Many times the firemen have been blocked while on their way to the upper rooms by furniture that was being carried down stairs, or by heavy trunks that have been dragged to the top steps and allowed to tumble down. If intelligence is used much can be done to protect property from the ravages of the flames. There is loss rather than gain in pitching one's effects out of doors, where, if it is not injured by the fall, it is more than likely to be trampled upon and damaged by the water thrown upon the fire. Paintings and pictures are among the things most easily ruined by heat and smoke. If the circumstances are favorable and there is time, these may be removed from their hangings on the walls of the threatened room. It is wiser to depend on the salvage corps, which responds promptly and understands the saving of household goods better than the owners, because the members of this corps have the experience, strength, and means with which to work. It is surprising to the onlooker how quickly household property can be gathered into the middle of a room and covered with protecting tarpaulins against injury by water or falling plaster. Sometimes, if the precautions mentioned are faithfully observed, a fire may be extinguished through the use of chemicals with only nominal damage.

Frost-bite and Freezing.—The first effect of long exposure to cold is to make the skin, usually of the fingers, toes, nose, or ears, numb, white, and wrinkled. Then, upon coming into a warm place, the parts become red, swollen, and itching. If the action of the cold has been severe, blisters form over the frozen skin, and finally mortification may set in. Generally, under proper treatment, the frozen part regains its sensation and becomes painful for a time, the swelling disappears, and there is no further trouble. In the case of those who have been nearly "frozen to death," the whole body is affected by the cold and there is unconsciousness. In the treatment of freezing, the patient should be kept in a cool room for some hours, and the frozen parts—or the whole body, if it is a case of general freezing—be rubbed with cold water or snow or wrapped in cold wet cloths. A bland antiseptic ointment may then be applied. The removal to a warm place should be made with the greatest care. Sometimes a frozen part may afterward be subject to chilblains.

Sunstroke.—The symptoms of sunstroke are a temperature of from 105° to 112° F., sometimes higher, a flushed face, stertorous breathing, and unconsciousness. The patient should be put into a cold bath and rubbed with ice. If at the seaside, he may be carried to the beach and put in the water; the head may be kept cold by bathing it or by the application of handkerchiefs wrung out of the water. If a cold bath is impossible, the patient may be douched with cold water from a hose-pipe or from pails, and cold cloths be kept on the head. The cold-water treatment must be continued until the temperature has fallen, after which the patient should be put to bed, and, if there is depression, be given stimulants moderately. Should the temperature begin to rise, the above treatment should be renewed.

Heat-exhaustion is caused by too long exposure to a very high temperature; the blood leaves the brain and the surface of the body and goes to the large blood-vessels of the abdomen. The symptoms are those of shock. The treatment is the same as that for shock: hot bath if possible, or heat applied to all parts of the body; stimulants of alcohol or strong coffee.

For lightning-stroke and electrical injuries the treatment is the same as that for shock and for burns.

Fainting.—The head of a person in a faint should be lowered and the feet raised, the blood being thus sent back to the brain. Plenty of air, the clothing loosened about the neck and chest, and a little cold water dashed over the face are usually sufficient to restore consciousness. A method often practised is to place the patient on a chair, and to push the head down between the knees, the hands hanging down at the side. The patient is kept in that position until the face becomes red, being then able to rise and walk about. This position restricts the abdomen and shuts off the blood-supply to the lower extremities, the blood going to the brain. Strong ammonia should not be held to the nostrils of an unconscious patient, as it is very irritating. The pulse should be watched, and, if consciousness does not soon return, heat should be applied and a physician be sent for. Little can be done for loss of consciousness from heart-failure beyond stimulating a flagging pulse until the arrival of medical assistance.

Drowning.—In asphyxia or suffocation from drowning, if the person when taken from the water is breathing, he should be removed, if possible, to a near-by house and put into a hot bath, which will act as a stimulant; or heat may be applied directly over the heart and other vital organs, the head and shoulders be raised, stimulants given, and the body briskly rubbed. This can be done until the arrival of a physician. In all cases of **suffocation** the throat must be cleared, so that fresh air can reach the lungs.

Artificial respiration is the imitation, as nearly as possible, of natural breathing. We breathe from sixteen to eighteen times a minute; this number of chest movements must not be exceeded, or the lungs cannot expand to fill thoroughly with air nor contract to expel the air.

To produce artificial respiration in case of drowning or of suffocation, the patient's clothing is first removed and the body is quickly dried. The mouth, the throat, and the nose should be cleared, and the tongue be pulled forward to facilitate access of air to the windpipe; a roll, a pillow, a rolled-up coat, or a piece of wood should be placed under the shoulders. The arms near the elbows should now be grasped and be swept around horizontally, away from the body, until the hands meet over the head (Fig. 117); this movement raises the ribs and expands the chest as in inspiration; the arms should then be brought down to the sides, the elbows meeting almost over the pit of the stomach (Fig. 118); pressure is then made against the chest-wall, producing contraction of the chest; the arms are to be held in the latter position

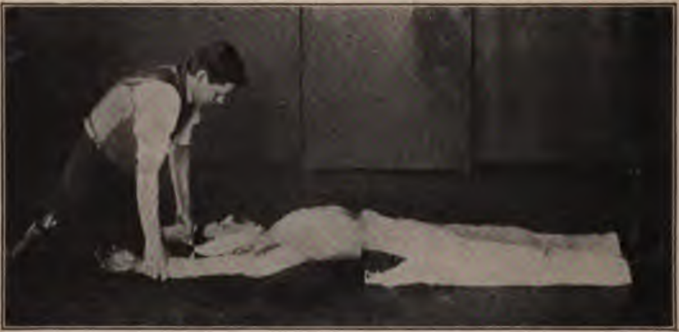


FIG. 117.—Artificial respiration: first movement, inspiration (Murray).

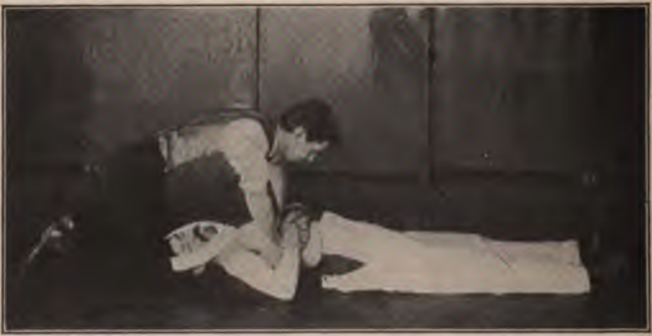


FIG. 118.—Artificial respiration: second movement, expiration (Murray).

a few seconds, and then the movements are repeated. From twelve to fifteen respirations will be sufficient. The mouth must be kept open and the tongue be held forward.

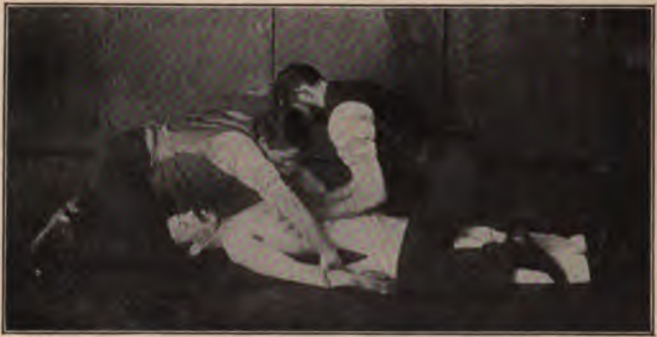


FIG. 119.—Artificial respiration: expiration, assistant exerting pressure on the chest (Murray).

Asphyxiation from Smoke.—To pass through sulphur fumes or smoke, one should hold a wet towel, a large wet handkerchief, or a wet cloth over the nose and mouth. The suffocation should be treated by artificial respiration and the use of stimulants, and any coincident burns should be cared for.

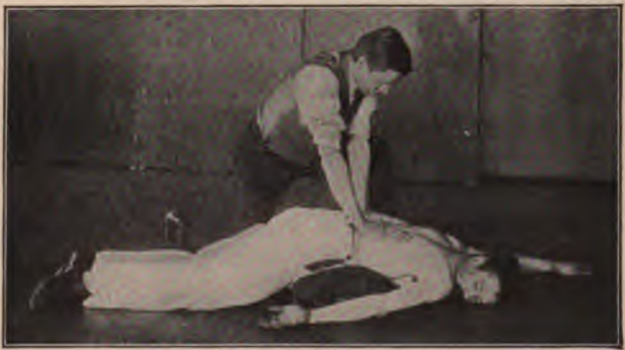


FIG. 120.—Expressing water from the stomach and lungs (Murray).

Asphyxiation from the inhalation of illuminating gas requires speedy removal into the pure air, artificial respiration, the inhalation of oxygen, stimulants, and the general treatment for suffocation.

Head-accidents.—For all accidents to the head, the part is to be bathed with warm water and firm pressure with a clean compress be made until the arrival of a physician. **Concussion of the brain** is the sudden interruption of the functions of the brain brought on by severe blows on, or by other injury to, the head. In the simple form of concussion the patient is partly insensible, the pupils are contracted, and the face is pale. In a few moments he may regain consciousness; there are nausea and vomiting and headache. In a severe case of brain-concussion death may very soon occur. **Compression of the brain** is due to tumors, to depression of the skull from fracture, and to other causes. The symptoms closely resemble those of apoplexy.

In both these injuries, until the arrival of a physician, who should be sent for at once, the patient should be placed in bed with the head slightly raised; the room should be darkened and cold applied to the head. If there is shock, heat is to be applied, but stimulants are not to be given without orders from the medical attendant.

Epileptic Convulsion.—A person seized with an epileptic fit should be placed in a safe position on the ground or floor, with the clothes loosened and a pillow or cushion placed under the head; he should be left so until the fit is over. Something should be placed between the teeth, to prevent the tongue being bitten.

Convulsions in children may be due to indigestion, pinworms, etc., or to brain-excitement in rickets or to irritation of the nerve-centers in teething. A great number of the diseases of children are ushered in with convulsions, which take the place of the initial chill in the adult. They may come on suddenly or gradually.

The child should be put into a hot bath (at a temperature of from 100° to 104° F.), without waiting to undress it, which can be done in the water. The head should be kept raised and cold applied to it. The hot-water bath will dilate the blood-vessels of the body, thus diverting the blood from the brain to the body. If the attack is the beginning of any of the eruptive diseases, the heat will also bring out the rash, besides relieving any pain in the abdomen or elsewhere. The child is to be kept in the bath about five minutes, and is then taken out and wrapped in a warm blanket; an enema is given to clear the bowels. A physician should be summoned at once.

In **hemorrhage of the lungs** (**hemoptysis**) the blood is bright red and frothy, from its admixture with air. In treating hemoptysis the head and shoulders are elevated and an ice-bag or an ice-poultice is applied to the chest; crushed ice may be given the patient to swallow. Equal parts of vinegar or lemon-juice and water, given in teaspoonful doses, or a quarter of a teaspoonful of dry salt, may assist in contracting the blood-vessels. Rest and quiet should be rigorously enforced.

Bleeding from the stomach (**hematemesis**) is treated similarly. The blood may be vomited, and the dark-red fluid may contain food; or it may be passed by the bowel. The throat and nose should be carefully examined, as the hemorrhage may have originated in these parts and been subsequently vomited.

In **nosebleed** (**epistaxis**) the head and arms should be elevated, and pressure with the fingers should be made on the nostril from which the blood is coming, or a small piece of lemon or a small piece of cotton wrung out of vinegar and inserted will contract the blood-vessels. The patient should not blow the nose, as it will disturb the formation of clots. Ice may be applied to the back of the neck and to the forehead.

POISONING.

Precautions in the Household Use of Poisons.—Accidental poisoning often arises from the administration of medicines from the wrong bottle. It is of great importance that all bottles in the house containing liniments, washes, disinfectants, etc., that are likely to be poisonous when taken internally, should be kept in dark-glass bottles and prominently labeled, and, in addition, marked "for external use only," "poison," or some other warning inscription, so that no member of the household may use them internally by mistake.

The first treatment in all cases of poisoning, except those caused by very corrosive substances, such as strong acids and alkalis, is *evacuation of the stomach-contents*. This may be accomplished by emetics, the stomach-pump, or siphon-tube. Before the arrival of medical aid there may be administered a large tablespoonful of mustard in a tumbler of warm water, or a solution of table-salt and warm water, not over one-half pint at a time, to avoid paralytic distention of the stomach-walls. These are very efficient household emetics, and may be assisted by tickling of the throat with either the finger or a feather. After vomiting, the patient should drink large amounts of milk or water, and the bowels should be emptied as soon as possible. Ordinarily, any vomited matter should be preserved for the physician's inspection.

If there are symptoms of collapse, such as weakness of pulse, feeble breathing, coldness of the body, insensibility, etc., the patient should be given *stimulants*, such as aromatic spirits of ammonia, strong hot coffee, strong hot beef-tea, brandy, or inhalations of smelling salts, ammonia, etc. He should be placed on his back, and be surrounded with *hot-water bottles* and covered with blankets. *Artificial respiration*, which is referred to elsewhere (p. 421), should be instituted if the breathing is very feeble or has entirely ceased.

The stomach-pump consists of a long pipe with a branch at right angles, and is so constructed that fluid can be pumped into and out of the stomach as desired, and so the organ can be thoroughly washed out. The **siphon-tube** is a long piece of rubber tubing with a glass funnel attached to one end. The tube is passed into the stomach, and the funnel raised above the patient's head. Warm or tepid fluid is now poured down the tube, and when filled the end of the tube is brought down to a lower level than the patient's stomach, when the stomach-contents flow out by siphon action. This is repeated until the fluid returns clear.

The irritant poisons act on the stomach and bowels, and the symptoms of all such poisons are generally the same. Coming in contact with the lips, mouth, throat, and stomach, they produce a burning sensation and give rise to vomiting and pain in the stomach and abdomen, the pain being increased upon pressure and by purging. The effects of the poisons are chiefly upon these organs, which they irritate and influence. After all irritant poisons, demulcent drinks, such as flaxseed tea, white of eggs, glycerin, sweet oil, starch-water, or warm milk, should be given to soothe the inflamed mucous membrane.

Strong acids and alkalis, by their destructive action on the tissues, may cause death. **Oil of vitriol (sulphuric acid)**, which may be taken as an example of this class, is occasionally taken by children or drunkards. Such a poison produces immediate symptoms—a burning pain in the mouth, which becomes white all over, vomiting, and collapse. If death does not rapidly occur, it may supervene later from perforation of the stomach as a result of the ulceration produced.

A powerful and not uncommon poison is **oxalic acid**, popularly known as acid of sugar. The destructive action is not so marked as in the case of the stronger acids, such as sulphuric and nitric. A burning taste in the mouth and pain in the stomach, with acid brownish vomit and marked collapse, are present. It rapidly causes death. No emetic should be given, but mild alkalis must be administered, and the collapse promptly treated.

In all cases of poisoning by acids we give alkalis (mild), such as chalk, magnesia, or common washing-soda, which we may find in nearly every house. Flour-and-water is a good mixture. When an alkali has caused symptoms of poisoning, the readiest remedy at hand is usually vinegar. Olive oil may be given.

Narcotic poisons act upon one or more parts of the nervous system, producing headache, giddiness, numbness, stupor, and paralysis, and often convulsions and death. They have not the burning taste of irritants, and rarely give rise to vomiting and purging.

Opium is used in many medicines and substances commonly kept in the household. Besides, it is a substance which is often taken habitually in various forms by some member of the family.

A patient the subject of poisoning by opium or morphin generally presents certain well-marked symptoms. At first there is a great tendency to sleep, with deep breathing, flushed face, and moist skin. The patient may often now be roused, but soon relapses into his former condition. As the symptoms progress it becomes impossible to rouse him. The breathing becomes irregular, the pulse feeble, and the pupils pin-point. There is a cold, clammy sweat. If death does not occur in twelve hours after the poison has been introduced into the body, there is a good prospect of recovery. There is often great difficulty in deciding whether the symptoms are due to opium-poisoning, apoplexy (hemorrhage into the brain), alcoholism, or uremia.

In the **treatment of opium-poisoning**, in addition to the general treatment of poisoning, it is necessary to rouse the patient and prevent sleep by every possible means. A good plan is to walk the patient about at short intervals; for this two persons are generally required, one on each side. Slapping the body with wet towels is also useful. The electric battery may be applied at short intervals. In advanced cases artificial respiration may be necessary, also stimulation of the heart by the battery. Strong hot coffee is a valuable and easily obtained remedy which must always be given; it may be administered by the mouth, stomach-tube, or by the rectum.

Belladonna, or **deadly nightshade**, and its active ingredient, **atropin**, are powerful narcotic poisons, often kept in households in the forms of liniments, eye-drops, etc. In cases of belladonna-poisoning the pupils are dilated, and, unlike in poisoning by opium, the patient shows evidence of noisy delirium, which attracts attention; hence, recovery is more frequent than in opium-poisoning. In addition to general measures there may be cold affusions applied to the head and face.

Alcohol is another common narcotic poison. Acute alcoholic poisoning often presents alarming symptoms, and death may occur rapidly. The symptoms are frequently very similar to those of advanced opium-poisoning. The breath usually smells of alcohol; but this is not reliable, as alcohol is often given to relieve symptoms which may be due to another cause. These cases should be treated by emptying the stomach and the application of cold affusions to the face, with stimulation of the body by warmth and hot drinks. A mustard-plaster may also be applied to the nape of the neck.

Prussic acid is a most virulent poison, often taken for suicidal purposes. It produces rapid insensibility. The patient lies on the ground, with staring eyes and dilated pupils. Breathing is slow and irregular, and the pulse is feeble or even absent. The rapidity of the onset of the symptoms, together with the peculiar penetrating almond-like odor of the breath, often enables us to detect poisoning by this substance. Where convulsions occur, the symptoms may resemble those of epilepsy. In the management of a case of prussic-acid poisoning the greatest promptitude is necessary. Cold water poured over the head and back is the best remedy, and one always at hand. It acts by rousing the respiratory functions. Artificial respiration must be kept up perseveringly. In fatal cases death generally occurs in half an hour or less.

Strychnin, the active ingredient of the nux vomica seed, is sometimes given or taken as a poison. It is often a poisonous constituent of **rat-poison.** The chief symptoms of strychnin-poisoning consist of muscular spasms and convulsions. The body becomes stiffened and arched. Unlike tetanus (lock-jaw), the jaws are affected later. The fits cease altogether for a minute or two, to return on the slightest provocation. Death usually results from exhaustion. In such cases emetics should be administered and cold affusions should be avoided. To relieve the spasms, it is usually necessary to place the patient under chloroform. The slightest noise or excitement, which may bring on or increase the spasms, should be prevented. The strength must be supported by all the means in our power. Artificial respiration may be required.

The following table, by Crozer Griffith, gives the more important points in the management of the commoner forms of acute poisoning:

TABLE OF POISONS AND ANTIDOTES.

POISON.	ANTIDOTES.
Acid, acetic, hydrochloric, sulphuric, nitric.	*An alkali*, such as magnesia, chalk, whiting, soda, soap; followed by soothing drinks or sweet oil.
Acid, carbolic; creasote . . .	*Epsom salt* in abundance; soap; no oil.
Acid, oxalic, including "salts of lemon."	Emetic, followed by *lime* (as chalk, plaster, whiting) or *magnesia*, but not by potash or soda; then soothing drinks.
Acid, prussic	Fresh air; ammonia to nostrils; cold douche; artificial respiration.
Aconite	Emetic, followed by *digitalis;* no pillow under head; free stimulation.
Alcohol (brandy, etc.). . .	Emetic; cold douche on head; warmth and artificial respiration.
Alkalis (as ammonia, spirits of hartshorn, lye, caustic potash).	*Vinegar* or *lemon-juice*, followed by soothing drinks or sweet oil.
Antimony (tartar emetic) .	Emetic if vomiting is not already profuse; then *tannic acid* freely or strong tea; ler, milk or other soothing; drinks at finally castor oil to empty the bowels.
Arsenic (Fowler's solution, Paris green, "Rough on Rats").	Emetic, quickly followed by *plenty of a fresh mixture of the tincture of chlorid of iron with calcined magnesia, washing- or baking-soda, or water of ammonia, or by Jeaunel's antidote.* Then white of egg, soothing drinks, or sweet oil; castor oil to empty bowels.

Atropin (see *Belladonna*).	
Belladonna (atropin) . . .	Emetic; *tannic acid* freely; cold to head; coffee. Stimulants and warmth if needed.
Blue stone; blue vitriol (see *Copper*).	
Chloral	Treatment as for opium-poisoning.
Chloroform, inhaled. . . .	Cold douche; friction of skin; inversion; artificial respiration.
Copper (blue stone; blue vitriol; verdigris).	Emetic, followed by *white of egg* or *milk*, *yellow prussiate of potash*; then soothing drinks.
Corrosive sublimate	Emetic, followed by *white of egg* or *milk*; soothing drinks; tannic acid freely; castor oil to open bowels.
Cyanid of potash (see *Acid, prussic*).	
Fowler's solution (see *Arsenic*).	
Gas (illuminating gas, coal-gas).	Fresh air; artificial respiration; ammonia to nostrils; cold douche.
Iodin	*Starch* or *flour* mixed with water, given freely; emetic; soothing drinks.
Laudanum (see *Opium*).	
Lead (sugar-of-lead) . . .	Emetic, followed by *Epsom salt*; white of egg or milk; alum.
Matches (see *Phosphorus*).	
Morphin (see *Opium*).	
Nux vomica (see *Strychnin*).	
Opium (including laudanum, morphin, paregoric, soothing syrups, etc.).	Emetic (but generally useless); *permanganate of potash* in doses of 4 or 5 grains if case is seen early; strong coffee; atropin; keep patient awake and breathing by cold douche to head and spine, walking, etc., but not to extent of exhaustion; artificial respiration.
Paregoric (see *Opium*).	
Paris green (see *Arsenic*).	
Phosphorus (match-heads, some roach and rat poisons).	Emetic; then *permanganate of potash* in doses of 4 or 5 grains well diluted; then Epsom salt or magnesia to open bowel, but no milk or oil of any kind.
Poisonous plants (Jimson weed, poisonous mushrooms, deadly nightshade, tobacco, etc.).	Emetic, followed by tannic acid; strong coffee or brandy; ammonia to nostrils; external warmth; artificial respiration.
Prussic acid (see *Acid, prussic*).	
Silver nitrate (lunar caustic).	*Table-salt*, followed by emetic; milk or white of eggs.
Spoiled food	Emetic, followed by castor oil as a purgative.
Strychnin (nux vomica) . .	Emetic, followed by tannic acid, *bromid of potash* freely, or chloral.
Tartar emetic (see *Antimony*).	

GLOSSARY.

A

Abdomen. The belly.

Abdominal. Pertaining to the belly.

Accommodation. Adjustment of the eye for various distances.

Adenoid. A tumor composed of glandular tissue.

Advancement. Detachment of an eye-muscle and reattachment at an advanced point.

Aëration. Purification by exposure to air.

Afferent. Passing or conducting from the periphery or the nerve-center.

Albinism. A congenital deficiency of coloring-matter in the skin, hair, etc.

Alimentary canal. The entire digestive tract from the mouth to the anus.

Alveolus. A small hollow, as a socket of a tooth.

Amblyopia. Dimness of vision.

Ametropia. Imperfection in the refraction of the eye.

Anemia. Deficient quantity or quality of the blood.

Aneurysm. A sac formed by the dilation of part of an artery and filled with blood.

Anisometropia. Marked inequality in the refractive power of the two eyes.

Antiseptic. A substance that destroys germs.

Antrum of Highmore. A cavity in the upper jaw, communicating with the nose.

Anus. The external opening of the lower bowel (rectum).

Appendix. See *Vermiform appendix*.

Aqueous humor. A watery fluid occupying that portion of the eyeball between the cornea and the crystalline lens.

Arcus senilis. A whitish ring occurring on the cornea, particularly in the aged.

Arytenoid cartilages. Two cartilages at the back of the larynx.

Aspergillus. A genus of fungi (moulds).

Asphyxiation. The act of causing suffocation.

Asthenopia. A weakness and speedy tiring of the visual apparatus.

Astigmatism. A defect of the eye in which the light-rays are not brought to a proper focus. A point of light is seen as a star.

Atrophy. A wasting away of a part.

Auditory canal. The passage that leads from the external ear to the ear-drum.

Auditory nerve. The nerve of hearing.

Auricle. 1. The external ear. 2.

The two upper chambers of the heart.

Aurist. Specialist in ear-diseases.

Auto-intoxication. Poisoning by some toxic or effete substance formed within the body.

Axilla. The armpit.

B

Binocular vision. Normal simultaneous use of the eyes.

Blepharitis. Inflammation of the edges of the eyelids.

Bronchi. The two main branches of the windpipe (trachea).

C

Canaliculus. A small canal, as the lacrimal canaliculus, through which the tears drain into the nose.

Canthus. The angle at the junction of the eyelids; the "corner of the eye."

Capillary. Any one of the hair-like vessels which conduct the blood from the arteries to the veins.

Capsule of Tenon. The sheath enveloping the eyeball.

Cardia. The opening of the esophagus (gullet) into the stomach.

Caries. Decay of bone; dental caries, decay of teeth.

Cartilage. Gristle.

Cataract. Opacity of the crystalline lens of the eye.

Cecum. The upper part of the large intestine.

Cement. The hard layer covering the root of a tooth.

Central nervous system. Brain and spinal cord.

Cerebral anemia. Deficient blood-supply to the brain.

Cerebrum. The brain proper.

Cerumen. Ear-wax.

Cholesteatoma. An encysted tumor containing cholesterin.

Choroid. The coat of the eyeball containing the blood-vessels.

Choroiditis. Inflammation of the choroid.

Chyme. Food which has undergone digestion in the stomach.

Cilia. 1. Eyelashes. 2. A small lash-like process.

Ciliary body. The pigmentary coat of the eye.

Ciliated epithelium. Epithelium provided with small hairs constantly in motion.

Clavicle. Collar-bone.

Colon. The middle part of the large intestine between the rectum and the cecum.

Coma. Morbid sleep or unconsciousness, as the uremic coma of disease of the kidneys.

Commissure. The line of junction between two similar intersecting surfaces, as commissure of the eyelids.

Compress. Folded cloth for applying pressure.

Cones. Cone-shaped bodies of the retina.

Conjunctiva. Membrane which lines the eyelids and covers the eyeball.

Conjunctivitis. Inflammation of the conjunctiva.

Cornea. The transparent front part of the eyeball.

Cortical centers. Nerve-centers of the cerebrum (brain proper).

Costal cartilages. Cartilages which prolong and attach the ribs to the breast-bone (sternum).

Cribriform plate. The upper perforated plate of the ethmoid bone.

Cricoid cartilage. The lowest cartilage of the larynx.

Crystalline lens. The transparent lenticular organ behind the pupil.

Curarization. Muscular weakness and paralysis similar to that produced by a drug called curare.

Cuticle. The outermost layer of skin.

Cyanosis. Blueness of skin or other tissues.

Cycloplegia. Paralysis of the ciliary muscle of the eyeball.

D

Dacryocystitis. Inflammation of the tear-bag.

Deglutition The act of swallowing.

Dejecta. The waste matter passed from the bowel; the feces.

Dentin. A brittle substance forming the main part of the tooth.

Depilatory. Having the power of removing hair.

Derma cutis. The true skin; the skin underneath the epidermis.

Dermatologist. A specialist on diseases of the skin.

Desquamation. Shedding of the skin.

Diabetes. A disease marked by an excessive secretion of urine, generally loaded with glucose (sugar).

Diaphragm. The partition which separates the chest from the abdomen.

Diathesis. Predisposition to disease.

Diplopia. The seeing of single objects as double.

Douche. A stream of water or other fluid directed against a part.

Duct. A tube through which the secretion of a gland empties.

Duodenum. The first part of the small intestine, beginning at the stomach.

E

Effleurage. Centripetal stroking movement in massage.

Elastic fibers. Fibers that compose tissue capable of returning to its proper shape after compression or stretching.

Emetic. A substance that causes vomiting, as ipecac.

Emmetropia. Perfect visual refraction; normal vision.

Emphysema. Abnormal distention of tissue by air or gas, generally applied to distended lung tissue.

Enteroptosis. A downward displacement of the intestines.

Entropion. Turning in of the eyelids or eyelashes.

Enucleation. Removal from an envelope. Enucleation of the eyeball is the cutting out of that organ from its membranous envelopes.

Epidermis. The outermost layer of skin.

Epiglottis. The lid of the larynx.

Epiphora. Overflow of tears.

Epistaxis. Bleeding from the nose.

Epithelium. The outer and bloodless layer of mucous membranes and of the skin.

Erectile tissue. Spongy tissue that becomes hard when expanded with blood.

Ergograph. Instrument for measuring work done by muscular action.

Esophagus. The canal which carries the food from the throat into the stomach. The gullet.

Ethmoid bone. A sieve-like bone of the nose.

Eustachian tube. One of two canals leading from the back of the nose to the drum of the ear.

Exanthematous. Characterized by an eruption or rash. The exanthemata are the rash-diseases, such as measles, chicken-pox, scarlet fever, etc.

Excrescence. A morbid growth projecting from a surface.

Exostosis. Abnormal outgrowth from surface of bone.

Extravasation. The escape of any fluid from its proper vessel into the tissue.

F

Fauces. The communication between the throat and pharynx.

Feces. Refuse material expelled from the bowels through the anus.

Fibroid phthisis. Interstitial pneumonia; chronic bronchitis.

Fossa. A pit, depression, or hollow.

Fovea centralis. Pit in middle of macula lutea; the sight-center of the retina.

Frontal bone. The bone of the forehead.

G

Gastric juice. The digestive fluid secreted by the stomach-glands.

Gastro-intestinal tract. The stomach and intestines. The bowels or gut.

Genito-urinary. Pertaining to the genital and urinary organs.

Germicide. An agent that destroys microbes.

Glands. Small organs occurring in different parts of the body and secreting fluids.

Glaucoma. Excessive pressure within the eye, leading to partial or complete blindness. Hardening of the eyeball.

Glottis. Aperture between the vocal cords.

Glucose. Grape-sugar, found normally in the animal body and abnormally in the urine in diabetes (glycosuria).

Glycogen. A carbohydrate from liver and other tissues.

H

Hair-follicle. The small depression in the skin from which each hair grows.

Hard palate. Front part of the roof of the mouth.

Hematemesis. Vomiting of blood.

Hematoma. A tumor containing blood.

Hemoglobin. The coloring-matter of red corpuscles of the blood.

Hemoptysis. Spitting of blood coming from the lungs, as in phthisis or consumption of the lungs.

Hepatic. Pertaining to the liver.

Heterophoria. Absence of parallelism between visual fields. Abnormality of ocular muscle-balance.

Holophane. A lamp-globe formed of prisms to deflect the light rays downward.

Humor. Any fluid or semifluid of the body.

Hutchinson teeth. A characteristic condition of the teeth seen in hereditary syphilis.

Hydrotherapy. Treatment of disease by means of water.

Hyperopia. Far-sightedness.

Hyperostosis. Excessive growth of bone.

Hypertrophy. Enlargement of a part.

Hypochondriasis. A mild form of melancholia.

I

Ileocecal valve. Valve at the junction of the small and large intestines.

Ileum. The last portion of the small intestine, joining the cecum.

Immunity. The condition of being protected against any particular disease, as from small-pox by vaccination.

Incubation. The period between the implanting of an infectious disease and its manifestation.

Insalivation. Saturation of food with saliva during mastication.

Insomnia. Inability to sleep.

Interstitial tissue. The connective tissue between the cellular elements of the body.

Intestine. That part of the alimentary canal extending from the stomach to the anus. The bowel or gut. The first portion is the *small intestine;* the second, and larger, is the *large intestine.*

Iridocyclitis. Inflammation of the iris and ciliary body.

Iris. The pigmented membrane behind the cornea, perforated by the pupil.

Iritis. Inflammation of the iris.

Isthmus of fauces. The passage connecting the mouth and pharynx.

J

Jejunum. That portion of the small intestine between the duodenum and the ileum.

K

Keloid. A tumor of the skin.

Kyphosis. A fore-and-aft bending of the spine. Hunchback.

L

Labyrinth. A term applied to the internal ear.

Lacrimal glands. The glands which secrete the tears.

Lacrimal sac. The tear-bag.

Laryngitis. Inflammation of the larynx.

Laryngopharynx. The lower portion of the pharynx.

Laryngoscopic mirror. A mirror used to examine the larynx.

Larynx. The organ from which the voice-sounds proceed.

Lens-capsule. A transparent sac that encloses the crystalline lens of the eyeball.

Leukocyte. A white blood-corpuscle.

Ligament. A tough band connecting bones or supporting organs.

Lobule. A small lobe.

Locomotor ataxia. A disease affecting the spinal cord, characterized by partial paralysis and a peculiar gait.

Lunula. The crescentic whitish area near the root of the nail.

Lymphatics. Small vessels pervading the body and containing lymph.

M

Macula lutea. The point of clearest vision at the center of the retina; the yellow spot.

Malleus. A mallet-shaped bone of the middle ear.

Mariotte's blind spot. The spot on the retina where the optic nerve enters.

Mastoid. The mastoid or nipple-shaped process of the temporal bone behind the external ear.

Meatus auditorius. The passage that leads from the external ear to the ear-drum.

Mechanotherapy. Treatment of disease by mechanical means, as rubbing, massage, bending, etc.

Meibomian glands. Oil-secreting glands of the eyelids.

Membrane. A thin layer of tissue covering a surface or dividing an organ.

Metabolism. The process by which the body-tissues are renewed and nourished.

Micturition. The passage of urine; urination.

Miotic. A drug which contracts the pupil, as eserin.

Mucus. The secretion from mucous glands.

Muscæ volitantes. "Floating flies." Specks seen as floating before the eyes.

Mydriatic. A drug that dilates the pupil, as atropin (belladonna).

Myopia. Near-sightedness.

N

Narcotic. A drug that produces sleep or stupor and relieves pain, as opium.

Nares. The chambers of the nose.

Nasal duct. The duct that conveys the tears from the tear-bag into the nose.

Nasopharynx. The part of the pharynx above the soft palate.

Neurasthenia. Nervous prostration.

Neuritis. Inflammation of a nerve.

Neuromuscular system. The system of muscles and their nerves.

Nystagmus. Continuous movement of the eyeball, horizontally or rotary.

O

Olfactory. Pertaining to the sense of smell.

Ophthalmia neonatorum. Inflammation of the outer membranes of the eyeball in the newborn.

Ophthalmoscope. An instrument for examining the interior of the eyeball.

Orbit. Bony socket that contains the eyeball.

Oropharynx. The lower part of the pharynx, which communicates with the mouth.

Ossicle. A minute bone; any one of the small bones of the ear.

Otorrhea. A discharge from the ear.

P

Palate. The roof of the mouth. There is a *hard* and a *soft* palate, which see.

Pantoscopic spectacles. Bifocal glasses.

Papilla. A small nipple-shaped elevation.

Paresis. 1. General paralysis. 2. Incomplete motor paralysis.

Parotid gland. One of the glands which secrete saliva.

Pathogenic. Causing disease.

Penicillium. A genus of mould-fungi.

Peridental membrane. The membrane covering the cement of the tooth.

Periosteum. The membrane investing bone.

Peritoneum. The membrane which lines the abdominal walls and invests the abdominal organs.

Pétrissage. Kneading action in massage.

Peyer's patches. Whitish patches of lymph-follicles in the small intestine.

Pharyngeal tonsil. A small body situated in the vault of the pharynx.

Pharynx. A musculomembranous sac lying behind the mouth and opening below into the esophagus.

Photometry. Measurement of the intensity of light.

Photophobia. A dread of light.

Phthisis. Consumption of the lungs.

Pigment. Coloring-matter.

Pillars of fauces. Folds of mucous membrane at the sides of the fauces.

Pinguecula. Yellowish spots on the conjunctiva.

Plantar ligaments. Ligaments of the sole of the foot.

Plastic operation. An operation for repairing injuries or deformities by forming new parts from surrounding tissue.

Plethora. A state characterized by swelling of the blood-vessels, due to excess of blood.

Plethysmograph. An instrument for measuring variations in size and blood-supply of a part.

Pleura. The serous membrane investing the lungs and lining the thorax.

Plexus. 'A network of blood-vessels or nerves.

Polyps. Small growths from a mucous surface, as nasal polyps, uterine polyps, etc.

Presbyopia. Impairment of eyesight due to hardening of the crystalline lens in advanced life.

Process. A prominence, especially on a bone.

Prophylaxis. Preventive treatment.

Protoplasm. The essential constituent of the living cell.

Pruritus. Itching.

Pterygium. A fleshy growth on the conjunctiva.

Pubes. The hair on the external genitalia, or the region covered with it.

Pulmonary tuberculosis. Consumption of the lungs.

Punctum lacrimale. An orifice on each lid leading into the lacrimal canaliculus and tear-bag.

Pupil. The opening in the center of the iris.

Purulent. Containing or consisting of pus.

Pylorus. The opening of the stomach into the small intestine.

Pyorrhœa alveolaris. Inflammation of the dental periosteum, with discharge of pus.

R

Rachitis. A disease in which the bones become softened and deformed; rickets.

Rectum. The lower part of the large intestine.

Regurgitation. The casting up of food just swallowed.

Rete mucosum. The innermost layer of the outer skin.

Retina. The perceptive membrane lining the inside of the eyeball.

Retinitis. Inflammation of the retina.

Rhinoscopy. Examination of the nose with the aid of a speculum and light.

Rickets. A disease in which the bones become softened and deformed; rachitis.

Ringworm. A skin disease occurring in circular patches.

Rods. Rod-shaped bodies of the retina.

S

Saliva. The fluid secreted in the mouth, an important digestive substance.

Salivary glands. Those glands which secrete the saliva.

Sarcolemma. Elastic sheath that encloses each fiber of striated muscle.

Scapula. Shoulder-blade.

Sclera. The membrane which, with the cornea, forms the external coat of the eyeball.

Scoliosis. Lateral curvature of the spine.

Scorbutus. A disease due to improper food; scurvy.

Scotoma. A blind or partly blind area in the field of vision.

Sebaceous glands. The glands which secrete the oil which lubricates the skin.

Semilunar area. The crescentic white area near the root of the nail.

Septum. A dividing wall or partition, as the nasal septum.

Sesamoid bone. A small flat bone occurring in a tendon playing over a bony surface.

Sigmoid flexure. That part of the large intestine between the cecum and the rectum, shaped like the letter S.

Singers' nodes. Enlargement of the edges of the vocal cords.

Sinus. A recess, cavity, or hollow space.

Skeletal muscle. A muscle attached to or moving some part of the skeleton.

Soft palate. Back part of the roof of the mouth.

Speculum. An instrument for opening to view a passage or cavity.

Sphenoid bone. The small wedge-shaped bone at the base of the skull.

Sputum. Matter spit from the mouth.

Stapes. Stirrup-shaped bone of the middle ear.

Sternum. The breast-bone, to which the ribs are attached in front.

Stertorous. Of the nature of snoring.

Stimulant. A remedy that excites functional activity in a part.

Stool. A fecal discharge.

Strabismus. Cross-eye; squint.

Sublingual gland. One of the glands which secrete saliva.

Submaxillary gland. One of the glands which secrete saliva.

Suspensory ligament. The ligament that supports the crystalline lens of the eyeball.

Syncope. A fainting condition.

Synechia. An adhesion, as of the iris to the cornea.

Syphilis. A contagious venereal disease.

T

Tapetum lucidum. The iridescent epithelium of the choroid of cats.

Tapotement. A tapping manipulation in massage.

Tarsal cartilages. Thin cartilages of the eyelids.

Temporal bone. Bone at each side and base of the skull containing the hearing apparatus.

Tenotomy. The operation of cutting a tendon.

Terminal plate. The terminal expansion of a motor nerve-branch.

Thermotherapy. Treatment of disease by means of heat.

Thoracic duct. A duct in which terminate the lymphatics of the lower limbs, abdomen, left arm, left side of the head, neck, and thorax.

Thorax. The chest.

Thyroid cartilage. The shield-shaped cartilage of the larynx.

Tinnitus aurium. A ringing in the ears.

Tonsils. Two almond-shaped bodies, one on each side, at the opening of the pharynx. These are the faucial tonsils. There is also a third tonsil, *pharyngeal*, which see.

Tourniquet. Instrument for the compression of blood-vessels to prevent access of blood to a limb.

Toxic. Pertaining to poisoning.

Trachea. The windpipe.

Trachoma. A contagious form of conjunctivitis; "granular lids."

True skin. The skin beneath the outer skin; the derma.

Turbinated bodies. Three small bones (*turbinated bones*) of the nose and their vascular coverings.

Tympanum. The middle ear or ear-drum.

U

Urea. A white crystalline substance from urine.

Uremia. Accumulation of poisonous matters in the blood, due to faulty elimination of diseased kidneys. It may cause convulsions or coma.

Uric-acid diathesis. A predisposition to the formation of an excess of uric acid.

Urticaria. Hives; nettle-rash.

V

Valve. A fold in a canal which prevents reflux of its contents, as the valves of the heart.

Valvulæ conniventes. Transverse folds in the mucous membrane of the small intestine.

Varicose veins. Greatly enlarged and contorted veins.

Vascular. Pertaining to, or full of, vessels.

Vasomotion. The contraction or dilation of a blood-vessel.

Vermiform appendix. A blind pouch in the upper portion of the large intestine.

Vibrissæ. The hairs within the nostrils.

Villi. Small projections from the lining membrane of the intestine.

Visual angle. Angle made at the eye by lines joining the extremities of objects and the nodal point.

Vitiligo. A skin disease characterized by white patches.

Vitreous humor. Transparent semifluid mass in the eyeball between the crystalline lens and the retina.

Voluntary muscle. Any muscle controlled by the will.

Vomer. Bone which forms the lower and back part of the partition of the nose.

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